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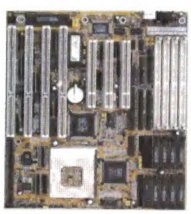

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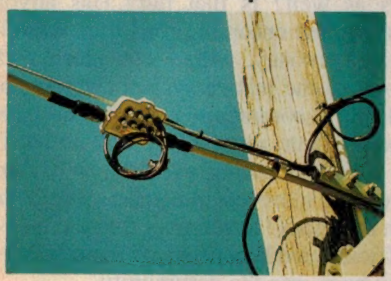
Volume 58, No.12
December 1996

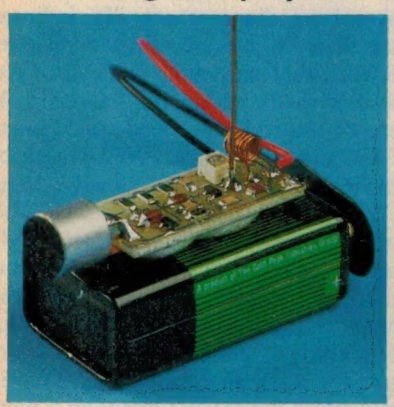
AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

HFC networks explained



Our new series of articles on hybrid fibre/coaxial cable networks and broadband communications continues this month with a look at reverse path planning and the supply of power for telephony. Written by Scientific-Atlanta's engineers, the article starts on page 6.

Interesting SMT project



One of our construction projects this month is a 'Baby Minder' FM wireless microphone, which also provides excellent experience in assembly of equipment using surface-mount components. See page 80...

On the cover

Recently Dick Smith Electronics opened its big 'new concept' PowerHouse store, in the Sydney suburb of Bankstown. It's very different from the firm's existing stores, as editor Jim Rowe explains in his story starting on page 33. Also shown is Rob Evans' exciting new Playmaster Pro Series Four Preamp (see page 58).

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Projects and Technical

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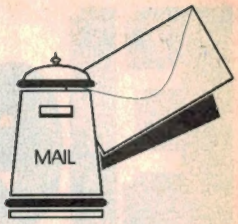
LETTERS TO THE EDITOR



Speed cameras

Referring to 'Moffat's Madhouse' in May 96, Tom Moffat has used his column to canvas some antisocial views regarding speed cameras. Quote 'there is a furious debate over whether these reduced driving speeds make roads any safer', and from a Canadian politician "get rid of speed cameras on the grounds that there is no evidence they reduced accidents".

Anybody seriously canvassing these arguments is obviously kidding themselves or short of a few facts — like for instance that the braking distance increases with the square of the speed. No right thinking person could seriously believe that the speed of a vehicle has no effect on the chances or outcome of an accident. The fact that Victoria's road toll made a sudden drop with the introduction of speed cameras should be evidence enough for anybody. The onus is obviously to prove that speed and speed cameras don't make a difference.

Regarding the 'car exceeding it (the speed limit) slightly... But during those critical seconds Click', given the (10% plus 3km/h) policy the actual allowance for speeding is at least 9km/h in a 60km/h zone, which is more than slightly over the limit. The 'plus 3km/h' takes into account any of the inaccuracies that Tom Moffat talks about.

As for 'infringing motorists human rights', motoring is one of the most destructive of others rights activities that we undertake. We charge through a space shared by the old, young, pedestrians, cyclists and other motorists in a 1.5-tonne projectile spewing pollution. To imagine that we should be allowed to do it at whatever speed we feel like denies others to the right of safety.

Greedy governments revenue collecting? Every year I pay several hundred dollars in various car insurances. The fact is that probably half of this is to pay for accidents and damage that is due to speeding. Any Year 11 physics student can prove that in a situation where it is just possible to stop from 60km/h, doing 70km/h would result in a 40km/h impact. This is why a decrease in average road speeds of just 5km/h with the introduction of speed cameras has made such a big difference in the road toll.

Why should the non speeders have to keep subsidising the speeders and put up with the increased risk from the speeders as well? Is that fair? Has anyone shown that enforcing road rules actually makes money, when considering the costs of the justice system (which Tom Moffat recommends using to the maximum extent) required to back it up? If it is a profit making exercise, why don't we have more speed cameras and police on the roads? Remember that the 'sea of official greed' consists of money that is put back into the community.

Colin Jeffery,
Dandenong North, Vic.

Valve connections

I would like to make a slight correction to 'All valves ain't', by Mr L.M. Cross in 'Letters to the Editor' July '96.

While I agree with most of the article, the term 'NC' (no connection) on a valve base diagram actually indicates that there is no electrical connection between that particular pin and any of the electrodes within the valve. In the case of the eight-pin octal bases, many of the pins designated 'NC' were also physically omitted from the valve base.

Equipment manufacturers were thus not precluded from using these 'NC' pins as convenient component tie points. Although I agree with Mr Cross that some unfortunate choices can occur, particularly if pin No.1 is used as a tie point for HT with the attendant 'surprises' waiting for anyone handling a metal version of a particular valve, used as a replacement for an original glass type.

On the other hand, the term 'IC' (internal connection), when used on octal, loctal, and miniature seven- and nine-pin bases means that the pin *does* have electrical connection to one or more of the valves' electrodes, but is not intended to be used as a working connection to the valve and certainly not for an external component or circuit tie point.

In many cases, as Mr Cross pointed out, the valve manufacturer had simply used the convenient ends of spare pins as structural support for some of the valve's internal elements.

All of this leads back to the unfortunate

state of affairs mentioned earlier, that not all valve manufacturers used the same 'spare' pins for 'internal connections'. As a result equipment manufacturers, using a specific brand of valve, could find that they had a genuine spare pin on a valve socket that could be used as a tie point. In later years when valve replacement became necessary, with a replacement from another manufacturer and probably another country, the fun started.

I hope that the foregoing assists in filling some of the gaps in our knowledge of the early valve era. Keep up the good work on the magazine!

Warwick Woods,
Glen Iris, Vic.

Different knob!

I trust that the author of the article on the History of Early Radar, part 3, published in the September 1996 issue, will not take offence at a gentle correction.

Fig.3.2 accurately shows a CH receiver being operated. However the caption draws attention to the large circular dial seen on the front panel, incorrectly describing it as a goniometer. In fact the dial controlled the rotor of a phase shift transformer, the effect of which was to alter the timing of the station's operation in order to avoid mutual interference with other stations, all of which were locked to the 50Hz mains.

The stators of the phase shift transformer were fed from three-phase 50Hz and by rotating the rotor the phase of the voltage induced therein could be varied continuously through 360°. The radiogoniometer was actually positioned by the operator's left hand, this making possible determination of the bearing of the reflected echo from the aircraft. With her right hand the operator positioned a cursor on the leading edge of the echo, thus determining the range. A crude calculator (based on telephone selector switching design) then converted the range and bearing readings to grid map references.

During my war service in the RAF as a Radar Technician I worked for a while on CH stations. The equipment provided a great deal of interest and fun to me, especially the transmitters which used exclusively demountable water-cooled valves.

Sid Yarrow,
Howick, Auckland NZ. ❖

Letters published in this column express the opinions of the correspondents concerned, and do not necessarily reflect the opinions or policies of the staff or publisher of Electronics Australia. We welcome contributions to this column, but reserve the right to edit letters which are very long or potentially defamatory.

EDITORIAL VIEWPOINT

A very sad farewell...

Please excuse any clumsy expression in this leader, which is being written with great haste so that it can be rushed to the printer, for a last-minute replacement of the original one I had written for this issue. It is also being written with great personal sadness, because only a couple of hours ago I learned that a good friend and respected mentor had passed away.

I feel sure that a great many of our readers will share my sadness, because the good friend concerned was Walter Neville Williams, the former Editor in Chief and more recently contributing columnist to this magazine. Neville passed away peacefully in hospital this morning, 7th November 1996, at the age of 80.

There is neither the space nor the time to give due acknowledgement to his life and career in this issue; we'll try to do so properly next month. However I can't end this notice without at least recording that Neville was by far the longest-serving editor of this publication. He began in January 1941, producing the magazine almost single-handed during World War 2, and didn't retire until 1983 — 42 years later. In that time he had performed the roles of Acting Editor, Technical Editor, Editor and Editor in Chief. And of course even when he had retired, he spent the succeeding 13 years writing for us as a regular contributor — at first with the Forum column, which he had begun back in September 1950, and then with his very popular 'When I Think Back' column.

So one way and another, he was committed to and worked hard for this magazine for an incredible 55 years — a record that has certainly never been equalled, and almost certainly never will be again.

It's trite to say that he achieved all of this well. Basically he was very highly respected throughout Australia's electronics industry even when I joined the magazine myself in January 1960. I well remember how nervous I was, at the prospect of working with the great W.N. Williams. His reputation was formidable, and when I had worked with him for only a short while I realised that it was well deserved. He had an encyclopaedic knowledge of the industry, a deep and solid understanding of electronics, and enviable skills in explaining technical concepts.

It was not Neville's style to flaunt his knowledge, or big-note himself. A modest and retiring man, with deep religious convictions, his aim was always to help both his colleagues and our readers understand things.

I know I learned an enormous amount from him, over the years, and I'm very grateful to have worked with him, learned from him and been honoured to have him as a friend. I'm sure many of our readers will feel the same way.

We'll present a better tribute to Neville next month, but in the meantime I hope you'll join with us in extending our deepest sympathies to Mrs Min Williams, their son Greg and daughter Jenny, and everyone else in Neville's extended family.

Jim Rowe

Scientific-Atlanta technology update series:

HFC NETWORKS AND BROADBAND COMMS - 2

Here is the second of a series of articles written for *EA* by the technical staff of Scientific-Atlanta Australia, to provide a good basic grounding in the new technology being implemented in the hybrid fibre/coax cable networks now being introduced in Australian cities by Optus Vision and Telstra. In this article we look at some of the general aspects of designing a broadband network.

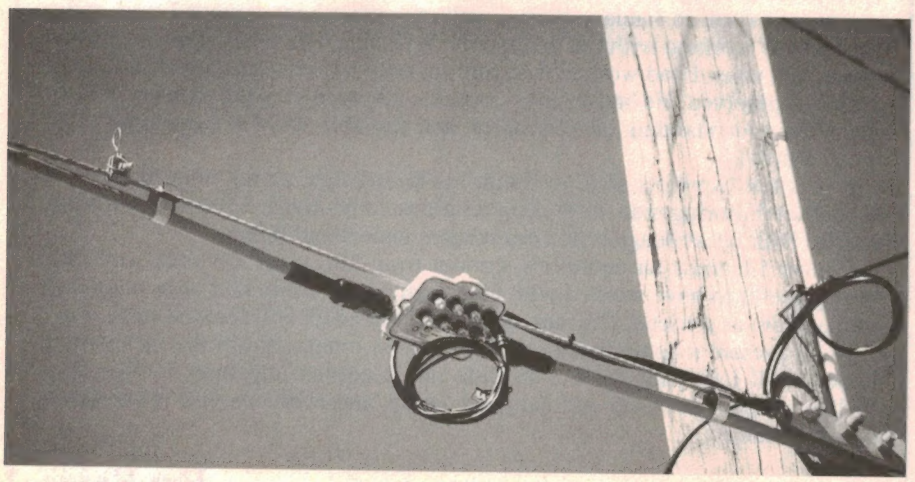
In the first of these articles last month, we introduced the various components that make up a broadband communications system. To recap briefly, hybrid fibre/coax or HFC networks contain three distinct parts: a headend, distribution plant and a series of individual subscriber connections. Where there is cable telephony deployed these subscriber connections are collectively referred to as an *access network*.

In Australia, Optus Vision is deploying an access network, while Foxtel is deploying a conventional CATV network. Both networks use HFC technology, making use of an optical fibre link to the serving area — the so-called FSA architecture. Most older networks built overseas use a trunk and feeder architecture. (See Figs.1, 2 and 3 for a comparison of each architecture).

Proponents of the FSA architecture claim a 'star' design is easier to upgrade as demand for advanced services increases. Network upgrades are typically driven by demand for bandwidth on the reverse path. The reverse path is used to transport signals from the home; e.g., in telephony and interactive broadband services.

In a trunk and feeder network, bandwidth allocated to the reverse path is shared by all households connected to the network. In an FSA network, only households within an FSA node share that bandwidth path. As more subscribers join the network, surplus capacity diminishes — particularly on the limited reverse bandwidth — forcing operators to either curtail services or increase the available bandwidth.

With an FSA network, available bandwidth can be increased by reducing the number of homes on each node. This is accomplished by simply sub-dividing an existing node into several sub-nodes supporting fewer homes. For example, a fibre node serving 2000 homes could be split into four smaller nodes of 500 homes. New fibre receivers are then installed to serve each 500 home node. This upgrade would effectively increase reverse path bandwidth available to homes in the original serving area of 2000 homes by a factor of four.



A Scientific-Atlanta subscriber tap unit attached to an Optus Vision cable in a street in suburban Sydney. This unit has eight outlets, but only one subscriber drop cable is currently attached.

Reverse path planning

Managing the growth of reverse bandwidth traffic is of prime importance to Optus Vision and Foxtel, as both plan to offer advanced services on their networks. Optus Vision already offers local telephony services, while Foxtel recently began offering high-speed Internet access services.

Optus Vision is targeting an aggressive 20% to 30% market penetration of existing telephone subscribers. However from a network design perspective, Optus Vision must plan for a higher penetration capacity. Cable telephony field trials overseas have shown that telephone service tends to be sold in small geographic clusters, by word of mouth among neighbours. As a result, one node may experience a 50% take-up rate compared to another node with minimal subscribers.

Other strategies, such as targeting apartment complexes, also lead to penetration variances between nodes.

Using a reverse path for advanced services such cable telephony places Australia in a pioneering role. While reverse-path transmission isn't a new technology (cable network operators overseas have been using reverse spectrum since the 1970s), the majority of today's reverse-path usage around the world involves simple applications such as impulse pay-per-view (IPPV) and status monitoring & control (SM&C).

These are 'polled' signals which require nominal bandwidth (less than 1MHz), and can be operated over a return path with little regard to node size and number of amplifiers deployed in the network. Path 'quality' is not as critical because headend control systems will continue to poll the network until a successful response is received from all devices.

Contrast this with cable telephony and Internet cable modem services, which occupy a larger spectrum window for a

longer duration. Here the path must be 'clean', as errors cause loss of connection or at best, a noisy phone call.

Reverse path planning is a particularly complex process because advanced services on HFC are still evolving. No uniform spectrum maps currently exist for reverse path use, so each vendor's product has its own approach to managing the reverse spectrum.

Take the case of cable telephony, where product performance varies widely among vendors. Optus Vision currently uses cable telephony products from two vendors, Motorola and ADC. Each vendor uses a different method of modulation, which we will discuss in more detail in a future article.

For now, it's useful to understand the two key areas that impact on reverse capacity in cable telephony: bandwidth efficiency and modulation schemes. By selecting different modulation techniques, the number of simultaneous lines which can be supported in each 1MHz of reverse spectrum varies widely.

The required bandwidth for individual cable telephony products varies between vendors, and will determine spectrum placement. At both the high and low ends of the reverse spectrum, group delay introduced by cascaded amplifiers increases. For example, a 2MHz-bandwidth carrier operating from 38 to 40MHz will experience approximately 200 nanoseconds of delay over a three-amplifier 'cascade'. The delay increases as cascades grow. This means that some cable telephony products requiring 2MHz or 3MHz signal carriers may not be able to use the high end of the reverse spectrum.

A cable modem service typically uses 1MHz or 2MHz channels, which can be scattered over the reverse spectrum. Various manufacturers' cable modems typically require up to 10MHz of bandwidth in which the service can be allocated.

Network powering

Australians expect telephony services to operate without fault. As a result, a network's design must contain adequate redundancy and emergency back-up facilities in the event of a power failure.

Cable telephony typically doubles the power requirements of an HFC network. This increase not only impacts on the cost of network deployment, but also affects the location and number of power inserters deployed in the network.

A typical powering design for cable telephony has two elements. At one end of the system is a headend interface unit (HIU), which connects the broadband network to the switched telephone network. The HIU is usually located in a facility where ample operating and emergency back-up power is available.

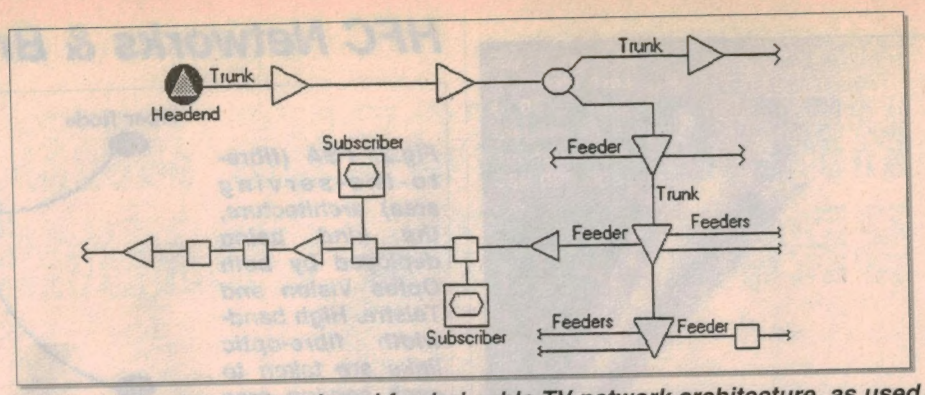


Fig.1: The traditional 'trunk and feeder' cable TV network architecture, as used extensively in older networks overseas. With this architecture reverse path bandwidth is effectively shared by all subscribers.

However at the other (subscriber) end of the system, the power requirements are more complex. Attached to the side of a home or located nearby is a customer interface unit (CIU), used to deliver voice signals to the customer. Operators have two options for powering the CIU: via the cable network, or by using a local power source.

Optus Vision is powering its CIU's from the network. This eliminates the need to maintain a separate back-up battery power supply in the home. Power is injected into the network at regular intervals along the Optus Vision cable. Power for individual CIU units is delivered via a composite cable connected to each network tap.

The Optus Vision composite cable contains a coaxial cable for carrying RF signals and a second twisted pair cable for carrying power. Power is drawn from the network using a power distribution unit (PDU) installed inside each tap. Twisted pair cables are connected to the PDU while coaxial cables are connected to the tap faceplate (Fig.4).

Network powering requires deployment of special multimedia taps in the network. These taps have several advanced features:

- A throughput of 10 amps, to accommodate increased network powering requirements;
- RF signal and AC bypass capabilities, to eliminate downstream service interruptions during field maintenance;
- Current-limiting circuitry, to protect the network from ground faults; and
- Advanced filtering, to isolate the RF signal from interference introduced by power cables going to individual homes.

Scientific-Atlanta's multimedia taps allow network upgrades on a home-by-home basis. For example, power for telephony and interactive services can

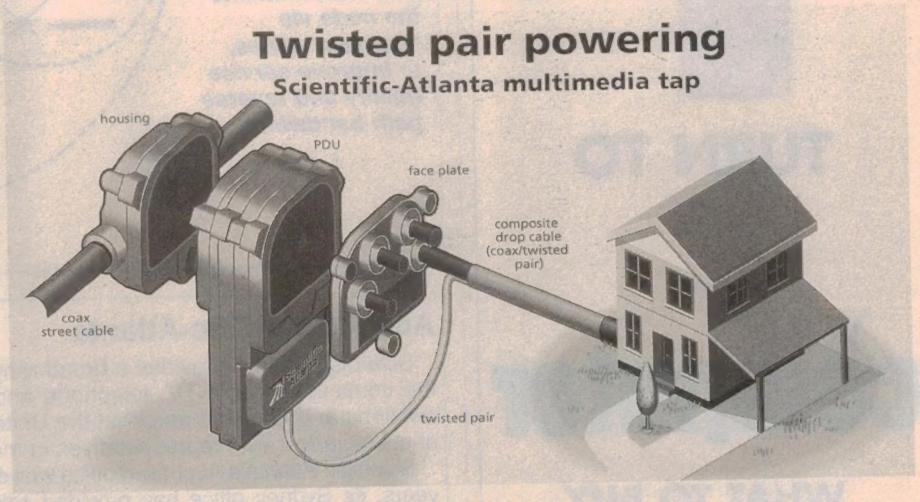


Fig.4: Scientific-Atlanta's multimedia tap can incorporate a power distribution unit (PDU) to provide power for a customer interface unit (CIU), as needed for telephony and interactive services. The faceplate can also be removed for upgrades, without disrupting service to 'downstream' customers.

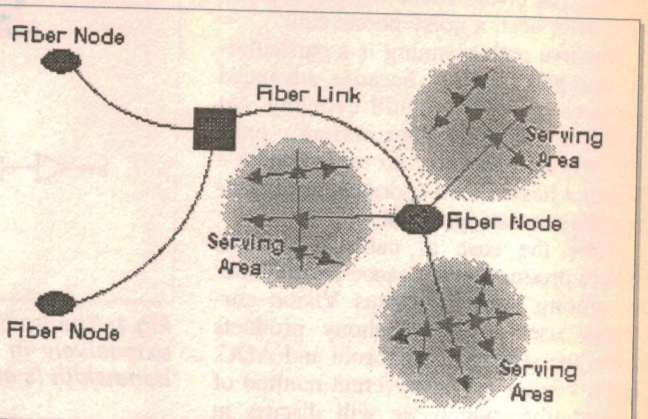


Fig.2: FSA (fibre-to-the-serving area) architecture, the kind being deployed by both Optus Vision and Telstra. High bandwidth fibre-optic links are taken to each serving area node.

be introduced by installing a PDU inside any Scientific-Atlanta tap already on the network. The PDU is designed to fit underneath a tap faceplate without modification. Tap attenuation values can also be quickly reconfigured with a simple faceplate change.

SA's technology lets this upgrade take place in the field without causing service interruptions to downstream customers. Earlier tap technology did not provide this benefit. Previously, any upgrade meant all downstream subscribers had to be temporarily cut off. In a telephony service environment, uninterrupted service is of course critical.

In the next article, we'll explain how a broadband cable is deployed, and look at the installation of key components such as taps and amplifiers. ❖

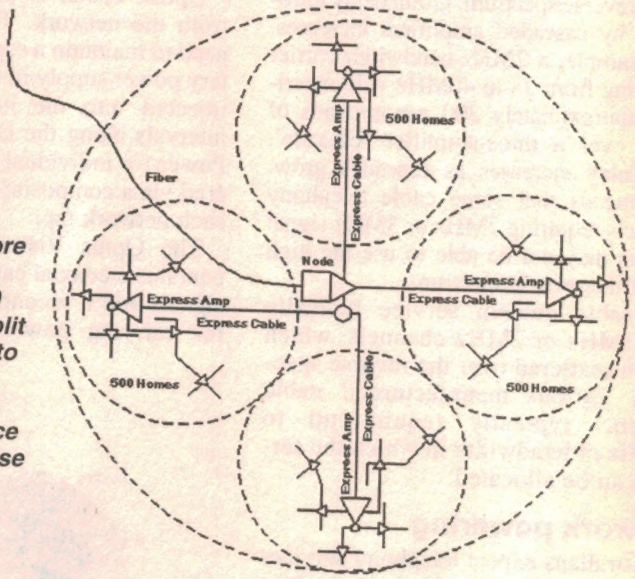
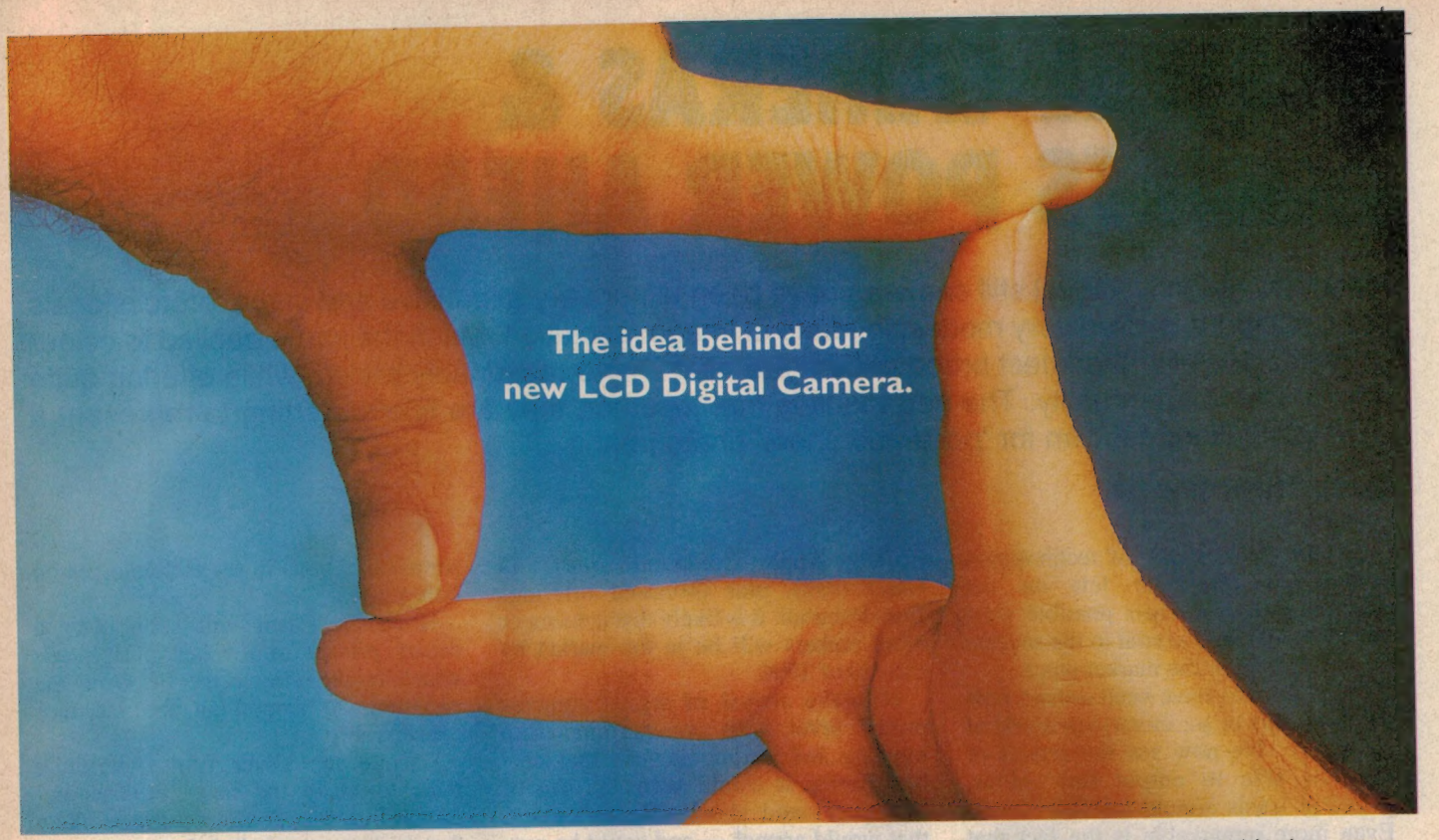


Fig.3: With FSA architecture a fibre receiver/node serving say 2000 homes can be split into four, linked to the node via 'express' cables, to improve service quality and reverse path bandwidth.

About Scientific-Atlanta

Scientific-Atlanta provides a broad range of communications delivery systems to the converging cable TV, telephone and computer industries. The company has divisions and offices throughout the United States and operates seven international subsidiaries, with representatives in more than 75 countries.

Scientific-Atlanta's Australian office was established in March 1985. For more than 10 years, its Sydney office has provided sales and technical support for customers in Australia, New Zealand and the South Pacific. Its customers include Optus Vision, the Department of Social Security, the Australian Broadcasting Commission, Network Ten, Sky Channel and Telecom New Zealand.



Instead of a viewfinder the Casio QV-10 has a big liquid crystal display. And unlike other digital cameras it's a standard feature not an expensive option.

The LCD gives you more accurate shots because what you see is what you get, it's also a multi- screen display allowing you to review one, four or nine frames at a time.

The JPEG based chip at the heart of the QV-10 stores up to ninety six images which can be down- loaded onto your computer (either IBM or Macintosh).

You can incorporate these images into documents, catalogues and newsletters and they can be used for exciting on-screen presentations and to create interesting internet pages.

You can print out hard copies or store on a floppy for use on other computers. Image data

can be converted to TIFF, PICT or BMP formats and imported into other applications.

And images edited on your computer can be transferred back to the camera as a handy portable reference!

Images can also be viewed on a TV and recorded onto video so you can create a library of stills.

With the Casio QV-10, stills photography has finally caught up with the digital revolution. Of course, being film-free there's the added advantage of never having to pay for film or processing ever again!

The QV-10 weighs only 190 grams (plus batteries) but it's certainly no lightweight when it comes to taking first class shots.

Exposure settings, back lighting and other conditions are easily monitored on the built-in screen.

It's got a 2 x zoom function plus macro capabilities so you can move right in for close-ups -for instance, if you want to shoot documents.

For fast moving objects there's shutter speeds of up to a remarkable 1/4000th of a second.

If you're looking for a digital camera the Casio QV-10 is definitely your best shot.

See for yourself at leading computer and camera retailers.

QV-10 LCD Digital Camera

Data exchange with a personal computer requires connection kit and is subject to certain systems requirements. Macintosh and IBM are registered trademarks of their respective owners. OZAD CASI 1836

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DIGITAL CAMERAS & INKJETS POWER AHEAD

Until very recently, digital still cameras have been either very expensive and in the 'professionals only' category, or else very modest in terms of image resolution. Much the same applied to colour printers. However the latest breed of both are much more reasonably priced, while offering quite impressive image quality. The nett result is that together, they are finally starting to represent a serious challenge to film for 'point and shoot' photography.

by BARRIE SMITH

In mid 1996, a pair of technologies made their presence felt on the Australian market: their possible partnership could be essential to the success of one of them in the market place.

Inkjet printers have been around now for five years or so, in varying levels of efficiency. We now see the arrival of versions able to output full colour, priced at levels around the $600 mark. Even more remarkable is the fact that competitive models from makers such as Canon, Epson and Hewlett-Packard are now capable of producing printouts at a near-photographic quality of 720 x 720dpi (dots per inch).

Parallel with the arrival of these high quality/low priced colour printers, a crop of new digital cameras also appeared, priced from a little over $1000, but with some models headed towards $500 and lower.

At this point in time the main camera players are Epson (one model), Kodak (three), Apple Computer (one) and Casio (two), plus promised offerings from Polaroid. It is likely that a dozen or more makers will be in the market by the end of 1996.

With the arrival of digital cameras priced level with conventional film models, and output devices that cost little more, it would seem the day of the 'point and shoot' digital camera that would appeal — and could be purchased by all — may finally have arrived. If so, such a development could well speed the demise of the venerable silver-based film camera...

If only the scenario were so simple: shoot your happy snaps on a digital camera, and make your brightly coloured prints (to any size you require) on an inkjet printer. Of course, the missing link is a computer — to act as go-between, downloading the images from the cameras and then controlling the printing operation. And there are still some limitations in the technologies on either side...

However, Casio will soon offer a direct printer and other peripherals which might remove the PC from the equation, so smoothing the interface considerably.

Despite the silver film fraternity's push to make the new 'PC-friendly' 24mm film format universal, it is likely that budget-priced digital cameras will assume more roles: newsletters, school publishing, etc. — and also aid the creation of low resolution images for WWW use.

Epson printers

What first drew *this* writer's attention to the matters above was a press preview of two inkjet printers and a digital still camera, from the Epson company.

First the printers. The Epson Colour Stylus 500 printer is an A4 model, able to output four-colour (CMYK) images at a resolution level of 720 x 720dpi (also configurable down to the 360 and 180dpi levels). The Epson Stylus PRO XL+ model can handle papers sizes up to A3 (329 x 483mm), with similar resolution to the 500 model.

Both printers can operate with Windows or Macintosh computers, with the PRO XL+ able to accept a PostScript Level 2 software package, thereby becoming highly useful to high-end DTP workers using software such as Quark Xpress.

Of the two, the 500 model is the most appealing for home and small office users. Output can be made on most types of paper, envelopes, cards and overhead transparencies, but the manufacturers recommend using special coated papers for maximum quality — especially where

Casio's QV10 camera images to a tiny 1/5"CCD sensor, with a resolution of 250,000 pixels.

The Epson Photo PC — very like a film camera, with onboard flash. This one is a Windows-only unit.

graphics or photographs are being reproduced.

Speed with inkjet printers has always been a sticky problem, and with full colour output it is even more a bugaboo. Because of this Epson went to enormous lengths to lift the performance of both models, then run competitive tests with its main rivals. The figures are illuminating:

A simple text page printed from MS Word 7 took the Epson 35 seconds to output, compared with 52 seconds for an HP DJ-660C, 22 for a Canon BJC-4100 and 30 for a Canon BJC-4100 with a BCI-2I cartridge.

A test page made up of graphics, photographs and text (and printed to coated paper) took the Epson 500 11 minutes and 43 seconds, the HP DJ-660C 12m 24s and the Canon BJC-4100 16m 41s.

Clearly, the Epson printer is faster than its competitors. The printed output is also superior in regards to text and colour presentation — but there might be some argument that a test run by Epson will impart bias towards its own hardware.

This writer took it upon himself to try out the A4 Epson Stylus 500 printer, using a Macintosh Centris 650 (68040 chip) computer, and fell foul of a number of problems. If you are intending to invest in this printer there are some matters you should attend to: in extracting the best graphics output you will need healthy amounts of RAM — real RAM! — and avoid the use of virtual memory or RAM doubling software. Quality output is heavily dependent on excellent processing power from the commanding computer.

Epson's digital camera

Very much like a film camera, with its on-board flash, the Photo PC is a Windows-only unit (486 or higher) — but is relatively bulky and heavy, at 310g plus four AA batteries. Like most of its breed it is fixed focus, but with auto exposure.

The lens is an f5.6/6mm, imaging to a 1/3" CCD (charge-coupled device) sensor. The pixel count is unknown. Shutter speeds vary from 1/30 to 1/10,000 sec. The serial interface is RS-232C. 24 bit colour images (16 at high resolution — 640 x 480 pixels, 32 at 'standard' 320 x 240 pixel resolution) are stored in flash memory with additional memory accessible by plug-in cards (up to 8MB) allowing a possible 80 high-res pictures to be stored.

Images can be downloaded as JPEG or BMP files. When output at 144dpi, the high-res images will create an 113 x 85mm print.

And the price of this very interesting and expandable device? $1149 including tax.

Casio's camera

I did not intend to review digital cameras in depth, but then the Casio landed in my lap and presented such a novel approach it deserved a closer look.

For one thing, unlike all other models on the market the

Above: A Casio QV10 image of the writer's daughter, showing how acceptable quality is possible — if the image is limited in size when output to print.
Right: An image of a suburban cinema taken with the Casio QV10. Highlight smear is one of the bugbears of CCD sensors in some situations.

Digital Cameras & Inkjets Power Ahead

Apple's QuickTake 150 camera can store 16 hi-res images, 32 standard images or a combination of both in its 1MB Flash EPROM.

Casio QV-10 avoids viewfinder parallax by the use of a colour LCD finder on the back of the camera. It can output an RF signal direct to a TV set or VCR. The images — totalling 96 in all — can be downloaded as digital files to a Windows or Macintosh computer. At this point they can be converted to a suitable graphics format (BMP, TIF, PICT), edited and titled (if that is your wont) in any software. Going further, this quite extraordinary device can then transfer the files back to the camera.

To give you some idea of the task undertaken by this tiny 70 x 40 x 66mm, 190g instrument, the original picture files are recorded as CAM files in internal 16-megabit flash memory, compressed as JPEG single-field files. Once unloaded you find they are all 28KB in size, but expand (in my tests) to around 900KB as TIFF files on a Mac. The camera info claims that the 96 picture files are stored within 2MB of memory.

When you return the TIFF (or whatever format you have taken them to) files to the camera, they are converted back to the camera's CAM format.

All of this leads to the camera's unique capacity to be used as a source of images in conference presentations, via a video/overhead projector. As a capture device for Internet-targetted colour images, the camera excels.

The camera is dead simple to use. You simply power on, select REC or PLAY, then fire the shutter button, and wait for the image to be committed to memory (two seconds); in replay you can cycle through the whole collection and delete unwanted pics.

Image quality is 640 x 480 pixels, producing a final printed picture of 135 x 102mm. The CCD sensor is a tiny 1/5" in diameter (250,000 pixels), coupled to a fixed focus (but selectable to two positions) lens of 5.2mm. The exposure system is TTL centre weighted. The electronic shutter operates via an aperture priority system and delivers a range of 1/8 to 1/4000 sec. White balance is automatic. Battery power is from four AA cells or the mains via an adaptor.

And the quality? Acceptable in printed form up to about 100 x 80mm. Surprisingly, the video reproduction on a 50cm TV screen equals that of an analog camcorder. For one who has spent the better part of eight years dissecting and writing about every video camera on the market, there is something unnerving about a still camera that can deliver similar quality.

But it's a pity about the LCD screen in full sunlight — you can't see a thing!

Two other problems were a pronounced thirst for batteries (four AAs at a time), and strong smear artefacts from bright highlights.

The hard — and imminent — reality is that cameras such as this (when they fall to around $200) and a fuss-free hookup to a colour inkjet printer (at a similar price) will surely outdistance the

Paper important, but not cheap...

Emphasising the importance of paper for inkjet printers, Kodak markets a Snapshot Inkjet Paper in 100 x 150mm size.

Using a base similar to photographic paper, it is coated with a proprietary material developed by Kodak specifically to support inkjet printing, allowing inks to dry quickly and aiding image clarity and saturation.

The quoted retail price for Kodak Snapshot paper is around $11.65 for a 36-sheet pack. Obviously, the great yellow giant also thinks there is a nexus between colour inkjets and digital cameras...

The Epson Colour Stylus 500 printer — an A4 model, able to output four-colour (CMYK) images at a resolution level of 720 x 720dpi.

Two of Kodak's cameras, the DC40 (left) and DC50. Both offer an image resolution of up to 756 x 504 pixels, and are compatible with either Macintosh or Windows computers. The DC50 features a built-in zoom lens, three image resolution levels, and extra image storage via PCMCIA cards.

'happy snapper' film camera we have come to love and cherish.

And the price? At present it's a recommended $799. A model with telephoto lens, the QV30, is also available, for $1299, and a new QV100 for $1199.

Kodak's entries

The Kodak DC20 Camera is the company's first digital camera to target the consumer market, selling at a suggested price of around $560.

It can store eight 24-bit 'hi res' 493 x 373 pixel images or 16 images of 320 x 240 pixels (normal mode), in Flash memory. The effective 'film speed' is claimed to be 800 - 1600 ASA. Weight is 110g without batteries.

Users operate three buttons: a power button to turn the camera on and off, a shutter button to take pictures, and another button to erase. Shutter speeds run from 1/30 to 1/4000 second. Images can be downloaded from the camera through an RS-232C port to a Mac or Windows PC.

A higher resolution level of 756 x 504 pixels makes the **DC40** a much more usable device. Many of the specs (lens, shutter) confirm the information that Kodak were the OEM for the Apple digital camera. The other differences from the DC20 include a 4MB memory card which allows 48 images to be stored. This model is again both Mac and Win compatible. It's selling at $1300.

Bolting on a 3x zoom lens (SLR equivalent 37-111mm) and allowing three image resolution levels makes the third Kodak model, the **DC50**, almost a real camera! PCMCIA cards can be clipped on to increase storage. This one is priced at $1650.

Apple's QuickTake

I used the first QuickTake camera back in mid 1994 and, while accepting the medium's limitations, was mighty impressed.

The current model, QuickTake 150, has double the shot capacity (16 hi-res pics, 32 standard or a combination) on a 1MB Flash EPROM, and the pics will remain in memory for a year even without the batteries. It works with a Mac or Windows PC.

Like many of its ilk, focus is fixed (a closeup lens permits shots within the 25-30cm range) and exposure is automatic — along with a 'bare bones' flash system. The programmed shutter speeds run from 1/30 - 1/175sec. The lens — an 8mm, imaging to a 1/3" CCD — is equivalent to a 50mm on a 35mm camera. The aperture range is f/2.8 to f/16. The effective film speed is claimed to be equivalent to ISO 85.

The camera weighs half a kilo. You can shoot up to 32 pics at 320 x 240 pixel resolution (which I found useless), or 640 x 480 pixel 'high res' — both in 24-bit colour. Once copied to the Mac or Win PC, the file sizes reach 30KB or 120KB respectively; a high-res file saved in PICT format can reach 900KB.

At first viewing the pictures are disappointing, but like its peers, sympathetic software can work wonders with these (relatively) tiny digital files.

The price for the QuickTake 150 is $995, bundled with the excellent PhotoFlash image editing software. ❖

Epson's Stylus PRO XL+ handles paper sizes up to A3 (329 x 483mm), with similar resolution to the 500 model.

KEEPING AN EYE ON THE IONOSPHERE

For many years, Australia's Ionospheric Prediction Service has been providing important information on radio propagation conditions and other phenomena determined by the state of the Earth's ionosphere — itself strongly under the influence of the Sun. Here's a look at how the IPS produces this information nowadays, using a range of instrumentation.

by GEOFF McNAMARA

International radio communication has been a way of life for decades, but the way radio signals are relayed around the curvature of the Earth has changed dramatically. These days the majority of transmissions are relayed by a combination of satellites and undersea cables. In the pre-satellite era, however, the only way to send a signal to someone over the horizon was by bouncing that signal off the ionosphere.

Those days aren't over, as many organisations prefer to remain independent of satellites and their owners. As a result, interest in the behaviour of the ionosphere — past, present and future — is alive and well, as is the organisation dedicated to providing that information: Australia's own Ionospheric Prediction Service (IPS).

IPS Radio and Space Services is a programme of the Commonwealth Department of Administrative Services. Their customers are many and varied, ranging from pipeline managers to miners to electricity providers. Even satellite operators have an interest in the behaviour of the Sun-Earth environment. Organisations like these need information about the current and future behaviour of the ionosphere.

To satisfy these needs, IPS not only monitors the behaviour of the Sun and the Earth's ionosphere, but makes accurate predictions of what the ionosphere will behave like following any disturbances on the Sun's surface.

The ionosphere that surrounds the Earth or any other body in the solar system is a thick layer of ionised atoms and free electrons. The dissociation results from the interaction of air molecules with high-energy radiation from the Sun, mainly at X-ray and ultraviolet wavelengths.

Many layers

The Earth's ionosphere, which extends from about 60 kilometres to over 1000 kilometres above the ground, is divided into a number of discrete layers: the D-layer, which lies below about 90 kilometres; the E-layer, from about 90 to 120 kilometres; the F1-layer (a daytime feature), centred on about 150 kilometres; and the F2-layer, centred on about 300 kilometres.

Since the ionosphere is the result of solar radiation alone, the degree of ionisation above a given place on Earth's surface depends the Sun's altitude in the sky as seen from that place. The Sun's altitude is influenced by some well-defined and predictable factors, such as time of day, season, and latitude.

What isn't so well understood or predictable is the variation due to the level of solar activity. This varies not only with the well documented 11-year solar cycle, but also on a day-to-day or even hourly basis. It's this almost random behaviour of the Sun that is of most interest to the IPS and its customers.

Disturbances on the Sun's surface include flares and prominences. Flares are sudden and violent eruptions of energy in the form of particles and radiation. In contrast, prominences are clouds of gas denser and cooler than the surrounding atmosphere of the Sun. These and other types of solar disturbance are capable of producing a range of solar 'radio bursts', which interfere with the Earth's ionosphere and, consequently, with radio communication.

The starting point for predicting ionospheric effects is to keep an eye out for these and other solar disturbances, and so IPS monitors the Sun daily using a variety of instruments.

The front line of the IPS monitoring system is its solar observatory at Narrabri in northern New South Wales. The observatory consists of a radio spectrograph and two optical telescopes which monitor the Sun's behaviour at a

The IPS solar observatory in Narrabri, NSW. Visible at left is the Carson heliostat and telescope, on its elevated platform. (Photo Brenda McNamara)

The solar optical telescope, fitted with a hydrogen-alpha filter. (Photo by Brenda McNamara)

range of wavelengths.

Richard Luckhurst, Technical Officer at the Observatory, explained the importance of monitoring the Sun using an array of radio telescopes: "The objective is to measure the output of the Sun at radio frequencies, because most solar events that are likely to have a terrestrial effect have a signature in radio." The three main antennas IPS uses to monitor the Sun operate at three bandwidths: 18 to 57MHz, 57 to 180MHz, and 180 to 1800MHz.

"We're extending that out to 5GHz with a new antenna under construction", added Luckhurst. "The output from the three antennas is fed into preamplifiers and then to Techtronics spectrum analysers, which we control with a PC. The observatory is now based on a Sun workstation, numerous PCs and a Power PC Macintosh."

Broadband spectrograph

At the heart of the observatory is a spectrograph that is capable of analysing and combining the radio signals from the antennas. The original instrument consisted of seven large racks of equipment that interpreted the data coming in from the antennas. These were replaced in 1992 by digital spectrum analysers which, as well as being more compact, give much better performance.

"It's the only broadband spectrograph of its type in the world", Luckhurst pointed out. "That's quite an achievement."

In fact, IPS is currently working with KEL Aerospace in Melbourne, which is helping the Indonesian government in manufacturing a similar spectrograph. IPS is also helping with a Japanese solar observing programme.

Back in 1992, the newly finished spectrograph received a baptism of solar fire: "We were very fortunate. Within days of completing the new spectrograph we had a significant solar burst", Luckhurst recalled, "That not only proved that it worked, but that it worked very well."

In addition to these antennas, the Observatory also has a microwave radiometer, an optical telescope for monitoring sunspot activity and a telescope fitted with a filter for monitoring the Sun in the hydrogen-alpha spectral line. These extend the range over which the Sun can be monitored.

The microwave radiometer is a 2.5 metre antenna housed in a large fibreglass sphere. "Once we get above about 1800MHz there's not a lot to be gained by scanning large frequency ranges", Luckhurst explained, "So we have three fixed frequencies, effectively just to improve the performance of the spectrograph up to 5GHz."

The optical telescope for monitoring sunspot activity is fed with an instrument known as a Carson heliostat — a tilted mirror fitted on a special mounting that allows it to track the Sun across the sky. The heliostat feeds the horizontally-mounted telescope with sunlight for as long as the Sun is up and the sky isn't clouded. The telescope then projects an image of the Sun onto a screen, which is routinely checked by the observer.

A second optical telescope is fitted with a very narrow bandwidth filter tuneable to the hydrogen-alpha line, one of a series of spectral lines in the visible spectrum created when electrons jump orbits within the hydrogen atoms that make up the bulk of the Sun. The filter cuts out most of the light from the Sun, but lets through the light at precisely the wavelength of the hydrogen-alpha line.

At this wavelength, most of the Sun appears relatively dark but solar flares shine brightly. When an observer looks through the eyepiece of the telescope or, more usually, watches a monitor, they see the Sun as a disk with solar prominences projecting off the edge.

"The filter's bandwidth is only half an Angstrom, but is tuneable to one Angstrom either side. That allows us to determine how bright a flare is", Luckhurst explained. "For every tenth of an Angstrom you tune off the H-alpha line, you can determine the flare's relative brightness."

Microprocessor control

IPS inherited the telescope when it was based on valves and very early semiconductor technology. Over the last five years Luckhurst has converted the telescope to microprocessor control. It currently uses a Vidicon camera that's well past its use-by date. In conjunction with NASA, however, IPS is developing a CCD camera with a 1024 by 1024 pixel array. When it's completed, the telescope will provide an image of the Sun every six seconds.

"That's going to be our key imaging instrument", says Luckhurst, "just as soon as we finish writing the software for it!"

Developing a CCD camera for solar work has presented some unique problems, however. "We've got the opposite problems to optical astronomers", said Luckhurst, "They don't have enough light, and we have too much!"

Despite the weakness of the image after it gets through the H-alpha filter — which is just enough for the Vidicon camera to pick up — the telescope is then fitted with neutral density filters and a mechanical shutter giving a 60 millisecond integration time. "That's still too much light for the CCD!" comments Luckhurst.

All three instruments — the microwave radiometer, the optical telescope and the Hydrogen-alpha telescope — are relics from the Apollo programme of the 1960s and 1970s. "When the Apollo project was active, NASA didn't want its astronauts outside the spacecraft during times of significant solar activity because of the

Keeping An Eye On The Ionosphere

radiation," explained Luckhurst, "So a solar-monitoring network was set up, called SPAN: the Solar Particle Alert Network. This involved stations around the world to monitor solar activity. The work we're doing now is really a follow-on from the Apollo programme work."

But it's at the Sun's radio wavelengths that the signs of an impending terrestrial ionospheric disturbance are read, and this is where the radio spectrograph comes in.

"The purpose of the radio spectrograph is to look at what we think are the precursors to type II events, which can lead to disruption of radio communication", Luckhurst explained. "We also want to monitor the event's duration. All this data gets fed into models of the ionosphere to see how severe the disturbance will be."

The human interface of the spectrograph is a monitor showing the last 38 minutes of solar emission, and is updated every three seconds. The monitor displays the intensity and frequency of solar radio emission over time.

Five event types

There are five classifications of solar radio bursts, based on their intensity and frequency behaviour over time. Event types are identified by looking at the shape of the curve displayed on the monitor. Type II events, for example, show a slow drift from high to low frequencies over time while Type III and V events have a much more rapid drift. In contrast, Type I events are characterised by many short-duration, narrow-band emissions. It's the Type II and Type IV events that observers keep an eye out for, however, since these have the greatest effect on Earth's ionosphere.

Identifying an event type is difficult, if for no other reason than they can come in a variety of combinations. The observatory is also subject to an increasing amount of radio interference from local radio and television stations.

"Fortunately, artificial radio sources are very narrow frequency bands over long time lines", explains Luckhurst, "while solar radio bursts tend to have a wide frequency range over fairly short times. This means the display of artificial interference on the monitor tends to be a narrow line perpendicular to the wide displays of solar bursts. This makes them easy for the observer to spot."

As soon as an event is identified, however, IPS begins sounding the ionosphere using several ionosondes located around Australia, Papua New Guinea and Antarctica.

The antenna array at the IPS observatory at Narrabri. At far left is the microwave radiometer dome. (Photo by Brenda McNamara)

"Most of our ionospheric sites are unmanned", said Luckhurst. "Until recently we used to get the data back via 16mm film once a month, but the majority of our ionosondes sites have been improved and are now controlled via PCs of various sorts. We can now get the data back via the Internet on a daily basis. The aim is to see just how severely the ionosphere has been affected by the disturbance. This is also passed on to IPS's customers."

While ionosondes sound the ionosphere regularly and can be called upon for extra soundings in the case of solar radio bursts, there are other triggers for extra soundings, such as a rapid increase in solar X-radiation measured by an orbiting satellite.

Of course, the main aim is to predict the likely effects before they occur.

"Most of the data from here is sent down to our Sydney office and to a number of similar organisations world-wide", said Luckhurst. "We put the whole picture together by correlating our ionospheric measurements with our solar data from this observatory, to predict ionospheric disturbances. As a secondary feature we tell our customers when there is a disturbance, how severe it will be to their services and how long it will last."

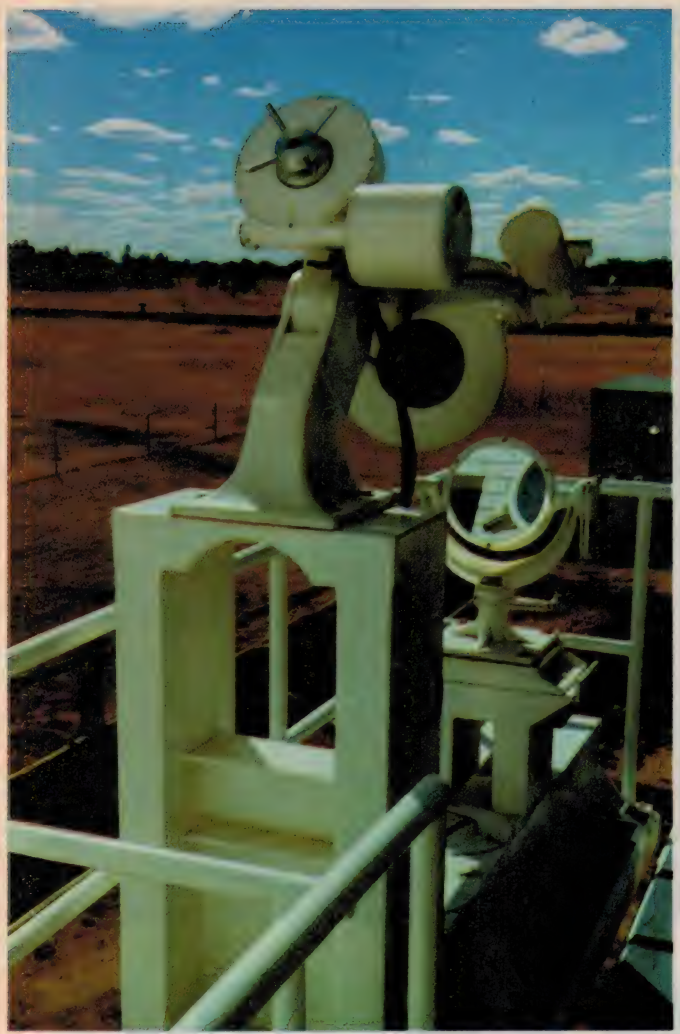
Many customers

So just who uses IPS's services? The largest customer area is in communications. One major user is the Australian Army. Because Australia doesn't have a large satellite network, the Army has decided to stick with HF radio communications using the ionosphere. This keeps them completely independent of any central satellite or communications system. During a war, isolated outfits would still be able to maintain communication, since it's unlikely any nation could 'take out' the ionosphere!

But even satellite operators are interested in the behaviour of the ionosphere. As the level of solar activity varies, so does the altitude of the outer layers of Earth's atmosphere. Satellites in low Earth orbit — an increasingly popular region for satellite users — are subject to atmospheric drag. At times of high solar activity the Earth's atmosphere swells up, reaching out for the lower satellites and shortening their lives.

Companies using pipelines and power grids are also very interested in the predictions offered by IPS. The problem is that solar events can induce currents in pipelines and cables.

"You get the same effect as a generator", explained Luckhurst, "except that instead of having a moving con-



A close-up view of the Carson heliostat and telescope. (Photo by Brenda McNamara)

ductor in a magnetic field, you have a moving magnetic field near a fixed conductor. The induced currents cause corrosion in pipelines, and induce DC problems into power stations and power lines."

Geomagnetic mining organisations use the data to identify unusual disturbances in their plots caused by changes to the magnetosphere caused by solar activity. Even GPS (Global Positioning System) users are starting to become interested. Changes in the outer layers of the atmosphere cause unaccountable refraction effects of the GPS signals.

IPS isn't alone in its efforts. "Most major countries are now involved in ionospheric work in some way", said Luckhurst, pointing out that the global monitoring has received a boost in recent years. "With the break up of the Soviet Union and the freeing of the eastern block, it's improved the world-wide coverage of solar and ionospheric observations."

With a continuing, even increasing need for information of the Sun-Earth environment needed by a wide range of customers, the IPS has a sure future in helping maintain global communications.

Biographical note

Geoff McNamara is a freelance science writer based in Sydney, Australia. He extends thanks to Richard Luckhurst for his help in preparing this article.❖

ANDY'S AMAZING ADVENTURE

In May this year, NASA space shuttle *Endeavour* carried mission STS 77 into orbit. This mission had special interest for Australians, as one of the crew members was Australian born career astronaut Dr Andy Thomas. Here's the story of STS 77, which also carried some interesting experiments including one which tested an 'inflatable antenna'.

by KATE DOOLAN

Now that plans for the long awaited International Space Station have been finalised and construction has started — at least on earth, anyway — the National Aeronautics and Space Administration (NASA) are using more of their space shuttle flights on preparations for the day that the Space Station is functional.

The recent flight of STS 77 was dedicated to furthering NASA's efforts to commercialise space and possibly justify the time and money that is spent on the space station, which has been maligned ever since plans for it were publicly announced. However to Australians, the flight of STS 77 will always remain special due to the fact that there was an Australian-born astronaut aboard. With the lack of space opportunities in Australia, the flight of STS 77 was a sad reminder that if an Australian wants to fly in space, they must go overseas to achieve their dreams.

One of the main payloads for STS 77 was the Shuttle Pointed Autonomous Research Tool for Astronomy 207 (SPARTAN 207). In one of the most ambitious SPARTAN missions to date, it tested the the Inflatable Antenna Experiment (IAE).

The SPARTAN carrier is a simple reusable vehicle that can carry an array of scientific instruments at a relatively low cost. After it is deployed from the space shuttle, SPARTAN provides its own power, pointing and data recording as it performs a preprogrammed mission. In addition to solar experiments, the SPARTAN spacecraft can be programmed to perform Earth fine-pointing, spacecraft technology experiments, stellar astronomy and microgravity science and technology experiments.

Managed by the Goddard Space Flight Centre in Greenbelt, Maryland, SPARTAN offers the scientific community a capacity for conducting investigations in space, intermediate between that afforded by small payloads that remain aboard the space shuttle and large satellites that orbit the Earth for extended periods of time.

The STS 77 mission of SPARTAN was unique in that the configuration of the IAE was a separate unit that could be ejected once the experiment was com-

pleted. Only the SPARTAN carrier with the equipment recorders was returned to the space shuttle's payload bay.

This was the second flight for the SPARTAN carrier concerned, which flew successfully on STS 63 in February 1995 (see *EA*, August 95). It was the fifth flight for the cross-bay SPARTAN support structure and the third flight for the Release/Engage Mechanism. STS 77 was actually the eighth SPARTAN mission to fly on the space shuttle.

Inflatable structures

The Inflatable Antenna Experiment (IAE) laid the groundwork for future space developments in inflatable space structures, which will be launched then inflated like a balloon in orbit. It was designed to validate the development and performance of a large inflatable antenna, during a 90 minute sequence. The antenna structure was then jettisoned before the SPARTAN was recovered at sequence end.

The inflation process was to be recorded by the STS 77 crew with a variety of still cameras, motion picture cameras and video cameras. The on-orbit performance of the antenna was evaluated by illuminating the antenna's surface with lights mounted on the SPARTAN and capturing the resulting patterns with SPARTAN's video recorders. These results have been undergoing analysis since STS 77 returned to Earth.

The IAE is a large inflatable antenna 14 metres in diameter, mounted on three 28 metre struts. Once in low Earth orbit, the SPARTAN became a platform for the antenna — which was almost as large as the space shuttle orbiter once inflated.

After SPARTAN was released from the shuttle's RMS arm, power was applied to begin the IAE programmed sequence of mission events. Upon command from the IAE controller, pin pullers securing the cover of the instrument fired, freeing the cover. Another pyro fired to release the side and front doors. The folded antenna was then released from the instrument canister, and pushed upward and out by the light panel on which it rested.

Once the light panel was freed, four springs pushed it upward. The inadvertent deployment of the antenna or the jettison of the canister/antenna assembly is considered a catastrophic hazard; therefore all pyro devices are inhibited by a two-fault tolerance.

The inflation system then pressurised the IAE's struts and torus with inert nitrogen gas, to inflate the antenna reflector. The nitrogen is stored at 20,685 kilopascals in two fibre wrapped aluminium tanks that are isolated from the remainder of the system by a enable/disable valve. The tanks and most of the system plumbing were retrieved along with SPARTAN 207.

The antenna reflector was dynamically inflated. It had three ventilation holes along its periphery that were sized to vent any residual air in the reflector at launch. The vent holes were small enough to maintain the very low nominal pressure needed for antenna rigidity.

Inflatable components show promise for space applications because they can be stowed in a much smaller area than an equivalent solid structure, which would significantly reduce the cost of future space missions. The Inflatable Antenna Experiment weighed only 60kg and an operational version could be developed for under US$10 million. Inflatable structures also have the potential for much more reliable deployment than conventional mechanical systems that deploy rigid structures.

Technology experiments

Another of the major payloads to fly on STS 77 was the Technology Experiments Advancing Missions in Space (TEAMS), which was mounted on a truss lying across the payload bay. It carried the following experiments:

1. Passive Aerodynamically Magnetically Stabilised Satellite (PAMS), which consisted of a small deployed satellite and measuring system to observe the satellite during the flight of STS 77.

Aerodynamic stabilisation is a method that can be used to position a satellite into a specific orientation whilst in low Earth orbit. Aerodynamic stabilisation works like a dart. The front of the dart is weighted and once the dart is thrown, it will always right itself with its head facing forward. In the same manner, the PAMS satellite was designed to orientate itself with the heavy end facing forward in orbit. This principle can be used to partially control the attitude of small satellites.

2. Global Positioning System Attitude and Navigation (GANE). This system used an array of Global Positioning System (GPS) receivers to perform differential position measurements to determine the attitude (pitch, roll and yaw) of the spacecraft relative to the celestial sphere. A system like GANE is being proposed for the International Space Station, and the STS 77 crew evaluated its performance at orbital velocities.

3. Vent Tank Resupply Experiment (VTRE). This experiment tested improved methods for in-space refuelling. Liquids were transferred from one tank to another while in orbit, as would be needed to refuel spacecraft. In a zero gravity environment, this is a problem because liquids do not pool and form free surfaces.

4. Liquid Metal Thermal Experiment (LMTE). The purpose of this experiment was to evaluate the performance

Australian-born astronaut Andrew Thomas posing for a photo inside the Spacehab Module, during the mission. The picture on the facing page shows Andy being fitted out, before entering Endeavour's flight deck to begin the mission.

of liquid metal heat pipes in zero gravity conditions.

Heat pipes are thermal management devices that are used on many existing and planned space systems for the purpose of waste heat removal. In their simplest forms, they consist of a tube containing a porous wicking material saturated with a working fluid. During operation, the fluid alternatively vapourises and condenses at different ends of the pipe as it absorbs and releases the waste heat.

Many different fluids are used including oxygen, ammonia and potassium, depending on the desired operation temperature. The three LMTE pipes contained potassium and were designed to operate at temperatures ranging from 300 - 1000°C.

Main payload

Inside the STS 77 shuttle orbiter, the main payload was SPACEHAB 4. This carried 10 commercial space development payloads in the areas of electronics materials, biotechnology, polymers and agriculture as well as several other experiments for NASA payload organisations. In all there were 1360kg of experiments and support equipment. The SPACEHAB module was located in the forward portion of the orbiter's payload bay, connected to the middeck by a short tunnel to allow the crew access to the laboratory.

The highest priority payload for SPACEHAB 4 was the Commercial Float Zone Facility (CFZF), which was a Canadian microgravity experiment examining the crystallisation of semiconductor materials with the 'float zone' technique. The aim was to attempt to exploit the low gravity of space to grow crystals that have fewer imperfections and defects than gravitational conditions are known to induce.

A secondary experiment was the Brilliant Eyes Ten Kelvin Sorption Cyrocooler Experiment (BETSCE), another microgravity experiment carrying an instrument that could quickly cool infrared and other sensors to near absolute zero.

Developed at the Jet Propulsion Laboratory, BETSCE was used to cool infrared sensors aboard the spacecraft down to 10K (-263°C). BETSCE was designed to demonstrate that cyrocoolers of this type called 'sorption coolers' can operate in the absence of gravity. Sorption coolers have essentially no vibration, are very efficient at extremely low temperatures and can operate reliably for over 10 years.

Crew details

The crew of STS 77 was publicly announced on June 13, 1995. Commanding the flight would be John Casper, making his fourth spaceflight. Pilot Curt Brown would be making his third spaceflight. Payload Commander Andy Thomas was making his first flight, while the Mission Specialists — who all had made space shuttle flights previously — were Dan Bursch, Canadian Marc Garneau and Mario Runco.

Australian interest in the flight of STS 77 was of course centred on Andy Thomas, who was born in Adelaide on 18 December 1951. After graduating from the University of Adelaide with a doctorate in mechanical engineering in 1978, Andy moved to the United States to become a research scientist with the Lockheed Aeronautical Systems Company.

With his eyes on becoming an astronaut since childhood, Andy became a naturalised American citizen in 1986, and in 1989 accepted a position at the Jet Propulsion Laboratory working on microgravity programs. In 1992, he applied and was accepted as an astronaut by NASA.

While Andy Thomas is not the first Australian-born person in space — that honour belongs to US Navy oceanographer Paul Scully-Power, who flew as a Payload Specialist aboard STS 41G in October 1984 — he is the first Australian born career astronaut to fly in space. (Phil Chapman, a Melbourne-born PhD in instrumentation was selected as an astronaut in 1967, but resigned from NASA in 1972 before making a spaceflight.)

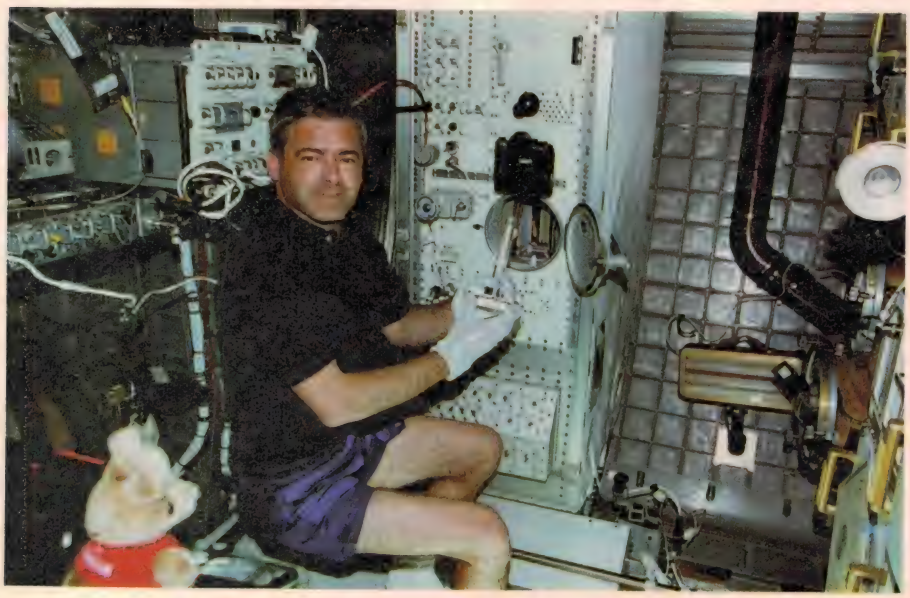
There is a definite difference between being a Mission Specialist and being a Payload Specialist. Mission Specialists are career astronauts, who undergo a rigorous selection process and demanding training, whilst Payload Specialists are trained for a specific purpose — usually on one particular space shuttle flight.

Smooth launching

Following its last flight on STS 72 in February 1996, space shuttle *Endeavour* was towed to the Orbital Processing Facility at the Kennedy Space Centre in Florida where it was refurbished for flight. On April 8, it was moved to the Vehicle Assembly Building where it was mated to the External Tank and Solid Rocket Boosters before being shifted to Pad 39B on April 16. Whilst *Endeavour* was on the pad, the SPACEHAB 4 module was vertically installed into the orbiter's payload bay.

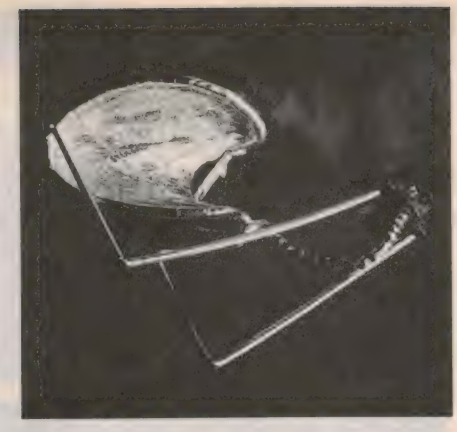
After one of most trouble-free countdowns in space shuttle history, *Endeavour* was launched at 6:30am (local time) on 19 May 1996. In what was an extremely rare occurrance, the launch was broadcast live on Australian television. (Thank you, Channel 2!)

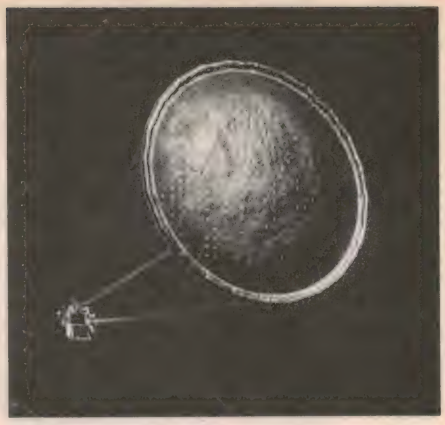
In Andy Thomas' words, "Needless to say, it was quite an amazing ride. The launch itself was an incredible sensation and I had a marvellous view out of the overhead windows as we climbed up and away from the coastline. It took us only eight and a half minutes to reach



Mission Specialist Marc Gameau works at the Commercial Float Zone Furnace in the Spacehab Module aboard Endeavour, during the STS 77 mission.

At right are two photos showing the Inflatable Antenna Experiment during inflation, and when completely inflated.





orbital velocity (28,157km/h) and shut down of the main engines. So we were in orbit before spectators at the launch had even left the parking lot!"

Endeavour was in a 283km-high orbit with a 39° inclination, which took the space shuttle over most of Australia. In honour of his Australian background, Andy took along a boomerang and pilot wings worn by early Australian aviators Sir Keith and Ross Smith.

Soon after *Endeavour* reached orbit, SPACEHAB 4 was activated. The crew (in particular Andy Thomas) had to get used to weightlessness:

"Learning to adapt and function on a day to day basis in weightlessness was quite a challenge, and you would be amazed how easily you can lose things in zero-g. But it was a lot easier to sleep in zero gravity than I thought it would be. All you have to do is strap yourself to the wall, floor or ceiling and close your eyes. It was very comfortable."

On the second day of the flight, the RMS arm released the SPARTAN 207 into a free flying mode. At this time, SPARTAN was stabilising itself in three axes with its cold nitrogen jets. The *Endeavour* then backed 120m away. All of SPARTAN's free flying operations were controlled by an onboard timer, which could not receive radio commands.

Two hours later, the Inflatable Antenna Experiment began its deployment sequence when the doors of SPARTAN opened with the antenna drifting into space. Inflation started 50 seconds after ejection, forcing some of the struts into a tight 'Z' shape. Seconds later, as the struts were pushing the dish away, one appeared to wrap itself over the antenna dish; but it cleared itself.

As the struts neared full extension after the start of the inflation procedure, their rapid motion shoved the 1220kg SPARTAN into oscillations of roughly +/-10 - 20°. The three-axis stabilisation was still active and damped the oscillations, but its gyro integrators saturated at 13° which caused a jump in a reference attitude.

Major oscillations were damped approximately 90 seconds after inflation occurred, with the IAE trailing SPARTAN in the desired attitude. Several minutes later, timers turned off the pitch and yaw channels of SPARTAN's attitude control system, as engineers expected the tenuous atmosphere of a 283km orbit would be stabilising and they did not want the attitude control system to bend the antenna. Roll stabilisation was left active to prevent gyroscopic coupling of any yaw and pitch motions.

It was uncertain whether the IAE was fully inflated. Under certain solar angles, unexpected crinkling reflections were observed and ripples could be seen on the surface.

Ten minutes into the deployment, the SPARTAN/IAE began to pitch down. Early rates were about one revolution every 3.5 minutes, but one hour later this had speeded up to every 85 seconds. SPARTAN roll stabilisation appeared to be effective, with little rolling noticed. The pitch plane was within 10 - 20° of the velocity vector. The cause of the pitching was unknown, with one possibility being a leak in the IAE.

The pitching made it difficult for the STS 77 crew to find a point for station keeping, so they moved *Endeavour* from 120 to 228 metres away from SPARTAN. Ground controllers told them that the centre of gravity was 2.7m above the bottom of SPARTAN, so *Endeavour* moved back to the original position of 120 metres.

Soon after, *Endeavour* moved 1000 metres away from the SPARTAN when it jettisoned the IAE. The timer jettisoned the antenna, after which aerodynamic drag caused it to drop into a lower orbit. It entered the Earth's atmosphere on 22 May, burning up over the Atlantic Ocean. The three spacecraft were easily observed from Earth, with the IAE in the lead followed by SPARTAN and *Endeavour*.

SPARTAN stopped rotating within a minute of jettisoning the IAE, as three-axis stabilisation was reactivated and its rate gyros remained effective. However, SPARTAN had lost some attitude reference at its gyro integrators had been saturated from the pitching and it did not have any other absolute reference. The new stable attitude was close to desired and did not require any unusual space shuttle manoeuvring for retrieval.

SPARTAN had also gained altitude after jettisoning the IAE, for unknown reasons.

Endeavour drifted 32km away from SPARTAN as the STS 77 astronauts slept. The following day, Commander Casper brought the space shuttle back for rendezvous with the spacecraft. Astronaut Marc Garneau then used the RMS arm to capture SPARTAN and then rotated it to look for clues on its altitude gains. But there were no recognisable patterns, so the SPARTAN was latched into the orbiter's payload bay.

During flight day three, the Passive Aerodynamically Magnetically Stabilised Satellite (PAMS) was deployed towards the Earth, but with the cylinder axis at an unstable 90° angle of attack to the velocity. The STS 77 crew noticed there had been a 'tip off' during the deployment, and early observations showed counter-clockwise coning of 10°.

Half an hour after the PAMS deployment, John Casper moved *Endeavour* 12km away. The shuttle did not remain in a station keeping position because this required propellant and ground controllers wanted to conduct observations as late as possible in the day. Using hand-held laser measuring devices, the STS 77 crew were able to range PAMS to at least 1800 metres.

Astronaut Casper fired *Endeavour*'s thrusters to return for a rendezvous with PAMS. *Endeavour*'s Ku-band radar had problems locking onto the satellite until it was six kilometres away. Early navigation used a star tracker and predicted ranges.

Once *Endeavour* was 600 metres behind PAMS, the trailing position was used for the first time so the orbiter's wake would be downwind and not affect the satellite. The attitude and coning of PAMS prevented the laser/camera from recording much data, but the motions were recorded on videotape.

Endeavour had rendezvous with

STS-77 Mission

PAMS two more times. The third rendezvous was a relief for scientists, as the orbiter finally got close enough to the satellite to take precise laser measurements. If this had not occurred, the scientists would have been forced to evaluate their experiment solely through radar data and the video footage captured by the astronauts.

A laser-based system designed to gauge the satellite's performance gave false readings and continued to do so until scientists worked out the kinks and managed four hours of excellent laser measurements. Scientists later stated that the experiment proved that a satellite could orient and stabilise itself with jet thrusters, which could lead to cheaper, longer lasting satellites. It is expected that the PAMS satellite will re-enter the Earth's atmosphere early next year.

Contact with Mir

During the STS 77 flight, John Casper was able to radio his astronaut colleague Dr Shannon Lucid on the Russian space station Mir. During the 15-minute chat with Dr Lucid and her Russian colleagues, Casper assured her that she would be picked up by space shuttle *Atlantis* in early August. However due to extensive 'O' ring damage in the solid rocket boosters on STS 78 in early July, her pickup would in fact have to wait until September — making Shannon Lucid the American who has spent the most time in space.

Taken from the Shuttle's aft flight deck, this photo shows the Spacehab Module in the cargo bay with the Remote Manipulator System on the right. Visible just to the left of the vertical stabiliser is San Francisco bay.

Andy Thomas spent time observing his country of origin from space, and commented "I got some impressive photos of the Earth and of Australia in particular (not many of Melbourne I am afraid). From space, it looks very red and is surrounded by a deep blue ocean. It is a very grand sight and I am looking forward to doing another spaceflight again at some point in the future."

There was also time in the flight for Andy to do a live television hookup with Channel 2. In the 15-minute interview, he commented on how much he was enjoying his flight — and showed off a toy kangaroo that was aboard as another passenger!

After a flight of 161 orbits and over eight million kilometres, the *Endeavour* landed at the Kennedy Space Centre at 7:09am on 29 May 1996 — bringing to an end the amazing adventure of Aussie astronaut Andy!

In closing, the author wishes to acknowledge the assistance of Colin Burgess and Debbie Dodds of the Johnson Space Center, Lisa Fowler and Margaret Persinger of the Kennedy Space Center, Mary Hardin of the Jet Propulsion Laboratory, and also Jenni Manning and of course Dr Andy Thomas, for their valued assistance in the completion of this article. All photos reproduced here are courtesy of NASA. ❖

NEW KITS FOR EA PROJECTS

From *Dick Smith Electronics*:

MINIOSC AUDIO OSCILLATOR (December 1996): The DSE kit is full form and comes complete with a high quality pocket-sized case. The metal front panel is pre-punched and silk screened, and all components are supplied as specified in the article.

Listed as Cat. No. K-7339, the kit is priced at $34.00.

From *Jaycar Electronics*:

PC-DRIVEN ARBITRARY & FUNCTION GENERATOR (December 1996/January 1997): The Jaycar kit is full form and includes case, PC boards, transformer and all components as specified. High quality IC sockets are included at no extra cost, and the front panel is pre-punched and silk screened.

Listed as Cat. No. KA-1792, the kit is priced at $99.00.

PLAYMASTER PRO SERIES FOUR PREAMPLIFIER (December 1996/January 1997): Jaycar has made this a 'Blueprint' kit, with top quality parts supplied throughout. The kit is complete with all components as specified. Both front and rear panels of the case are pre-punched and silk screened, and the power transformer is a low-radiation toroidal type. All RCA connectors are gold plated, and all resistors of the high stability metal film variety.

Listed as Cat. No. KA-1790, the kit is priced at $299.00.

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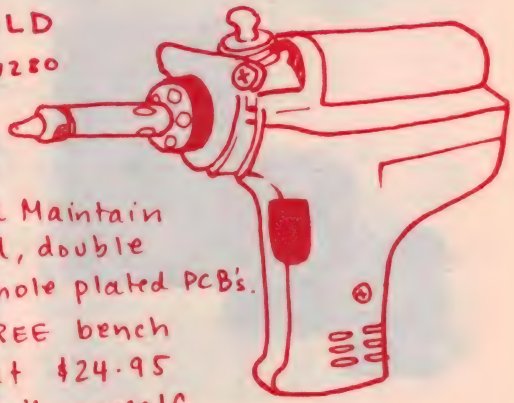

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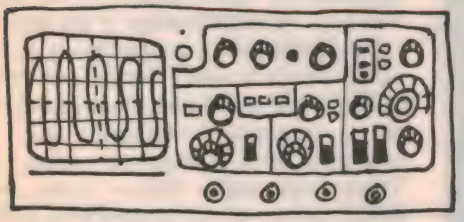

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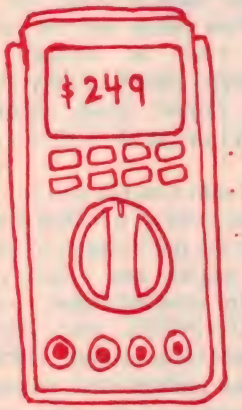

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What's New in VIDEO and AUDIO

Speakers for contractors, from JBL

JBL Professional has launched the JBL Control Contractor Series, a new range of speakers aimed at the entire market of indoor and outdoor, fixed installation, background music and paging system applications for consultants, contractors and designers.

The four model range includes the compact Control 23, 25 and 28 two-way systems, with symmetrical 90° x 90° horns which allow the speakers to be 'aimed' to meet specific zone coverage requirements, with accurate control maintained in both vertical and horizontal array. The Control SB-2 subwoofer is specifically tuned to complement the full-range speakers.

The series offers significant advances such as as JBL's patented Invisiball wall mounting hardware, and ready-to-paint textured and weather-resistant enclosures. Invisiball is a unique mounting system that not only ensures rapid installation and prevents theft, but also allows horizontal rotation of up to 37° and vertical rotation of up to 44° off-axis.

Materials such as HIPS (high impact polystyrene), polypropylene, zinc-coated steel and titanium coatings have been used for long term durability.

The new range is distributed exclusively in Australia by Jands Electronics and retails from $595. For more information circle 143 on the reader service card or contact Jands at 578 Princes Highway, St Peters 2044; phone (02) 9516 3622.

Video projector uses TI's Micro-mirrors

The new Electrohome Vista Pro high-brightness projector is claimed to be the first commercially available video projection system based on the Texas Instruments three-chip Digital Light Processing (DLP) engine.

The new all-digital Vista Pro projector offers over 1100 ANSI lumens of brightness, plus accurate colour reproduction, seamless imagery, digital accuracy, colour uniformity and scaleability to higher resolutions. Designed for large audience venues where vivid image and high ambient light must work together, it's claimed to be ideal for video, data and multimedia projection.

A key subsystem in the unit is TI's DLP engine, featuring the Digital Micromirror (DMD) device, a highly integrated semiconductor light switch. The initial

three-chip DLP subsystem integrated into the Vista Pro projector combines high brightness, colour saturation and light efficiency with true 24-bit colour, for accurate colour reproduction.

The three-chip professional DLP subsystem uses a colour splitting prism to separate white light into red, blue and green, illuminating each DMD with one colour. The three colours are then recombined into a single lens for projection onto the screen. Each DMD continuously displays one colour, therefore eliminating any potential light loss due to a colour wheel or sequential loading of the device.

The Vista Pro is compatible with all world-standard video formats as well as DOS, Windows and Macintosh personal computer formats, and is equipped with composite video, S-Video with audio follow video and RGBS inputs. It is equipped with a 500 watt CERMAX Xenon lamp with an integrated reflector, providing high-brightness and excellent colour consistency throughout the life of the lamp. The lamp module is designed for safe and easy replacement by end users.

The Vista Pro projector measures a compact 677 x 560 x 299mm (W x D x H) and weighs 33kg. For further information circle 141 on the reader service card or contact Amber Technology, Unit B, 5 Skyline Place, Frenchs Forest 2086; phone (02) 9975-1211 or fax (02) 9975-1368.

Mitsubishi 68cm CTV

Recognising the trend to larger-screen TV receivers, manufacturer Mitsubishi Electric has launched a new range of receivers claimed to offer outstanding value for money.

The new 68cm CT-29GHI, for example, is said to feature some of the best TV technology available — including auto picture adjustment (which ensures the best picture quality regardless of ambient lighting conditions or your viewing distance from

the TV); auto turn (so you can sit back and at the press of a button move your set 20° to the left or right, to get a good viewing angle); and a built-in Super Woofer for improved bass sound.

The CT-29GHI also features a smart, new style cabinet; NTSC playback; and audio/video memory settings, so you can adjust the sound and picture to match different types of programmes.

The CT-29GHI is available at electrical retailers nationally, for an RRP of $1899.

Big sound from new Yamaha mini

With a unit delivering 45 watts per channel, Yamaha Music Australia has introduced its most powerful mini system to date. The new model GX50, which replaces the US Grand Prix winning GX5, is priced at only $699 but delivers 10 watts more power, and features three-way rather than two-way speakers.

The GX50 is a three piece system featuring a component module containing a preamp, tuner, CD changer, twin auto reverse cassette deck and Active Servo Technology amplifier, plus separate speakers. Active Servo Technology is a complementary amplifier/speaker system which employs negative impedance feedback and other electronic processes to derive strong and accurate low bass from small speaker enclosures.

Yamaha has also incorporated a new feature into the GX50's cassette deck: CD Synchro Start, for convenient dubbing.

The GX50's three-disc CD changer uses eight-times oversampling technology and Yamaha's S-Bit D/A converters. It also features Yamaha's PlayXchange, which allows the user to swap two of the three discs while the third is playing.

The Active Servo Technology three-way speakers incorporate a 140mm cone multi-range driver, 50mm cone tweeter, super tweeter, and air woofer.

For further information, circle 144 on the reader service card or contact the Consumer Electronics Division, Yamaha Music Australia; phone (03) 9699 2388, 1800 805 413 or fax (03) 9696 4579.

Car audio components feature K-BUS control

Kenwood has released three new top-end components to its range of car audio technology: the CR-F900 Cassette Receiver with CD/MD changer control, the DR-F900 CD Receiver with CD/MD changer control, and the DE-F700 CD Player with Graphic Equaliser.

With conventional car audio components, you usually need to make separate connections and cabling for power, audio signal, and control signals. But these new Kenwood components feature K-BUS, a centre control bus system, which allows the components to communicate with one another via a single specialised K-BUS line cable. This two-way communication conveys all control function data, display information, power supply and audio signals between the components.

Both the CR-F900 and DR-F900 feature four channels with a maximum power output of 35W each; full CD/MD changer control; (DNPS) Disc Name Preset; a high sensitivity tuner and FM diversity antenna capability.

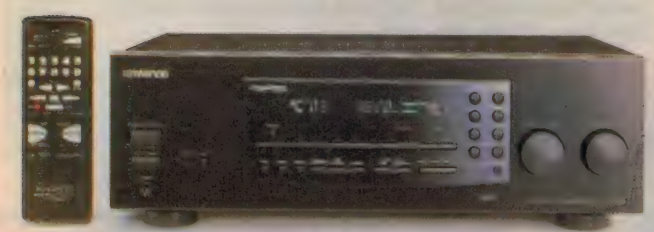
The DR-F900 CD Receiver and the DE-F700 CD Player/Graphic Equaliser both feature quad single bit digital-to-analog converter systems with eight-times oversampling technology, reproducing unprecedented resolution for a car audio system. The CR-F900 Cassette Receiver boasts a full-logic tape transport mechanism for finger touch reliable operation, and Dolby B noise reduction to minimise tape hiss. For added convenience, both the DR-F900 and CR-F900 feature wireless remote control.

The DE-F700 CD Player with Graphic Equaliser features a seven-band graphic equaliser with three preset and three user EQ curves, and a four-pattern 'spectrum analyser'.

The RRP for the DR-F900 is $1399, with $1199 for the CR-F900 and $999 for the DE-F700. Kenwood's car audio products are all covered by a 12-month warranty and available at selected Kenwood car audio dealers. For further information circle 142 on the reader service card or call Kenwood on (02) 9746 1888.

Pro-Logic surround sound, keenly priced

Kenwood claims to have combined powerful home theatre features in its new and competitively priced KR-V7080 Dolby Pro-Logic Surround Sound A/V Receiver. The KR-V7080 features a Dolby Pro-Logic Surround Decoder and offers three channels of 100 watts from the front (left, centre, right) plus 25 watts for each of the rear channels. In addition a pre-out connection with volume control caters for connection to an active subwoofer.



A Macro Play feature stores the last panel settings, enabling them to be recalled at the press of a button. Other features include a direct source facility that bypasses all the tone controls for 'pure' sound, and a multi-level control that permits individual control over each channel.

Inputs cater for phono, CD, tape deck, auxiliary and connection to two VCRs. An Easy Touch universal pre-programmed remote control makes operating the KR-V7080 simple and convenient.

The KR-V7080 has an RRP of $1029 and is covered by a 24-month warranty. For further information on Kenwood's KR-V7080, please circle 140 on the reader service card or call Kenwood on (02) 9746 1888. ❖

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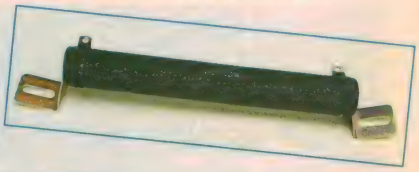

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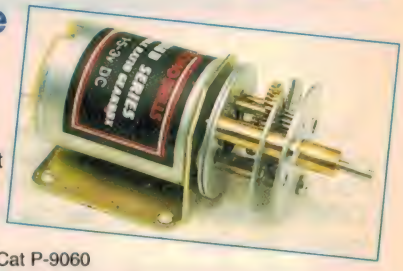

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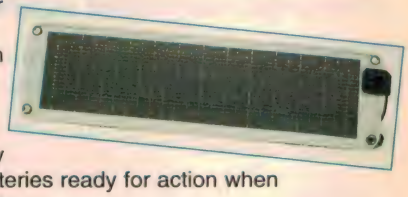

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Video & Audio: The Challis Report

TECHNICS SL-MC400 110-CD PLAYER/CHANGER

This month our reviewer Louis Challis has been testing a new CD player/changer from Technics, with a capacity of no fewer than 110 discs. The SL-MC400 offers very impressive performance in many respects, although the early sample sent for review did display minor shortcomings...

Most of you will have some nostalgic memories of either your own, or your parent's record players and changers. Record changers were very popular because they avoided the constant need to get up from one's chair to change the records.

When CD players hit the market and each disc played for between 30-70 minutes, there initially seemed no need for a CD changer. The lucky few who had a CD player had relatively few discs, and consequently there was no demand for CD changers. But as CD collections grew the public's perception changed. When Pioneer released its first six-disc cartridge CD player, I was convinced that CD changers would grow in popularity.

Today, apart from mini systems, CD changers constitute the largest segment of the market, and they are growing in popularity. Whilst many, if not most people are currently satisfied with a CD player that can store and play three, five, six or even 10 CDs without personal intervention, even those options embody some limitations.

Four years ago I saw my first 'CD jukebox'. Its price appeared to match its size, and by that I mean it was both big and expensive. Surprisingly, although samples were brought into Australia by at least two manufacturers, there was no serious effort made to market their products. But since that time, I am aware of a number of manufacturers who have developed CD changers capable of holding at least 100 CDs. All of those CD changers were displayed at the 1996 Winter Consumer Electronics Show in Las Vegas.

Whilst four of those CD players hold precisely 100 discs, one has upstaged the rest, as it has a capacity of 110 discs. Wow! Just imagine your entire collection of CDs stacked ready to play in a CD player, with pressing a button or two the only effort required to play any one or all...

Now for many people that idea is attractive. For in the lazy/busy society in which we find ourselves, it is frequently tiresome to start searching through a stack of CDs to find the one you want, and then carefully extract it from its 'jewel case' to load into the CD player.

The shelf or cupboard space required to store all those CD jewel cases is considerable. And frankly, although the jewel cases may appear impressive in the record shop, they are far from beautiful.

Even with those people lucky enough to own more than 110 CDs, it's likely that they'll acknowledge that only a small proportion or their collection are played regularly. I certainly fall into that category, as does my wife, and the chances are that you too conform to the same rules.

Technics' changer

The advantages of the Technics SL-MC400 CD player are many and varied. The first advantage is that the CD player's cabinet is only 430mm wide, which is approximately the same width as most hifi equipment. That ensures that the CD changer will fit into a conventional 19" rack. It must also be acknowledged that to permanently accommodate 110 CDs in such a confined space is a noteworthy achievement in itself.

When you drop the front panel down, your eye immediately focuses on this inordinately large number of narrow slots. Each slot is neatly numbered (from 1 to 110), at the lower bevelled edge in front of the slots. Obviously, if you had to load so many discs into such a tight situation without further assistance, you would undoubtedly experience problems. Panasonic has however applied considerable fore-

thought. Its designers have installed a neat solution in which a sliding loading carriage is provided. This allows you to index the carriage into the correct numbered position and after placing the disc into the carriage, you then tip it into its designated slot.

That system works well, as I discovered. However, it also provides you with an equally effective method for extracting a disc from its slot. All you have to do is to press the little pushbutton on the side of the loading carriage, and voila! your disc is ejected. The disc rolls back into the loading carriage ready for you to extract it — using fingers placed around the perimeter, or a finger into the centre hole.

Panasonic provides a notebook-like binder, with clear plastic pages and adhesive numbers. Using that folder you can stick the two liners from the disc's jewel box into the plastic organiser and label each folder with the adhesive numbers provided.

With the hinged lid returned to its normal upright position, you have access to a normal array of primary player controls such as STOP, PAUSE and PLAY, which are located at the lower right-hand side of the panel. Immediately above those controls are four additional controls — FAST FORWARD and REWIND, and TRACK SKIP FORWARDS and BACKWARDS.

Immediately to the left of the primary controls are five buttons labelled 'A' to 'E', which provide access to five dedicated groups of CD slots. Those groups may be allocated and labelled from amongst the following headings: BALLADS, BLUES, CLASSIC, COUNTRY, DANCE, FAVOURITE, HIP HOP, JAZZ, NEW AGE, OLDIES, PARTY, POP, ROCK and ROMANTIC. Any one of those designated groups can comprise up to 110 discs, and if you so choose, a disc can be assigned to more than one group.

Regrettably, the SL-MC400 does not make provision for you to assign titles to either a disc or group, other than those which are provided. However it does provide a programmable 132-step playback sequence, which can be programmed using either the front panel keys or the player's remote control.

A step can be a whole disc or a track from any disc. The most convenient way to build up the steps is to assemble the next step in the sequence by selecting from the track that is currently playing. Fortunately the program is retained in memory even when the power is switched off, for otherwise the system would simply not work.

The front panel and the remote control both have access keys to select tracks 1 to 10, and tracks greater than 10 in increments of 10. There are also pushbuttons provided for GROUP ENTER and a separate key again for ID scan, which is a convenient means of searching a given disc for a specific track.

When the ID function key is pressed, the CD will start searching from the beginning of the track for a loud section, and will play 10 seconds of the track centred around that point. If that happens to be the track which you are

Measured Performance: Technics SL-MC400 CD Player

Serial No. FG6CE01011

1. FREQUENCY RESPONSE 5Hz to 20kHz +0.9, -0dB

2. LINEARITY

Nominal Level	Measured Output L Ch, dB	Measured Output R Ch, dB
0dB	0.0	0.0
-1.0	-1.0	-1.0
-3.0	-3.0	-3.0
-6.0	-6.0	-6.0
-10.0	-10.0	-10.0
-20.0	-20.0	-20.0
-30.0	-30.0	-30.0
-40.0	-40.1	-40.1
-50.0	-50.1	-50.2
-60.0	-60.2	-60.2
-70.0	-70.8	-70.9
-80.0	-83.0	-83.2
-90.0	-102.8	-103.0

3. CHANNEL SEPARATION

Frequency	Right Into Left,dB	Left Into Right, dB
100Hz	-90.0	-90.5
1kHz	-102.5	-95.5
10kHz	-83.0	-76.0
20kHz	-76.0	-70.5

4. DISTORTION

1kHz output:

Output Level	2nd Harmonic	3rd Harmonic	4th Harmonic	5th Harmonic	THD %
0	-110.5	-97.3	—	-114.2	0.0014
-10	—	-102.5	—	-105.6	0.00092
-20	—	-91.8	—	-99.9	0.0028
-30	-86.9	-76.3	-89.8	—	0.016
-40	—	-69.9	—	-76.8	0.035
-50	-67.1	-58.2	-67.0	-59.1	0.18
-60	-50.6	-43.3	-55.4	-46.5	0.90
-70	-39.8	-31.7	-48.5	-38.1	3.08
-80	-22.7	-15.1	-28.9	-27.6	19.8
-90	+2.2	-6.0	-7.2	-10.4	148

100Hz output:

Level	2nd	3rd	4th	5th	THD%
0	-101.4	-103.5	-120.0	-109.9	0.001
-20	-82.7	-84.7	-100.8	-92.4	0.0097
-40	-63.8	-70.5	-84.5	-66.8	0.085
-60	-38.6	-30.5	-47.0	-38.0	3.5

6.3kHz output:

0	-97.3	-105.0	—	—	0.015

5. EMPHASIS

Frequency	Recorded Level	Measured Level (L)	Measured Level (R)
1kHz	-0.37dB	-0.43	-0.43
5kHz	-4.53dB	-4.23	-4.23
16kHz	-9.0dB	-9.4	-9.4

6. SIGNAL TO NOISE RATIO

Track 23	Without Emphasis	-87 (Lin)	-98.5dB(A)
Track 24	With Emphasis	-87.2 (Lin)	-98.7dB(A)

7. FREQUENCY ACCURACY

Recorded signal 19.999kHz: Measured output 20,027.75Hz

8. SQUARE WAVE RESPONSE

See X-Y Plots appended

9. IMPULSE TEST

See X-Y plot appended

10. DIRTY RECORD TEST

Interruption in Information Layer (Sony/CBS Test Disc): Passed all levels up to and including 2500um

Black dot at readout side: Passed

Black stripe test: Passed

11. VIBRATION OR DISPLACEMENT TEST

Operates satisfactorily at 0.3G RMS

searching for, all you have to do is press the PLAY button, and the changer will play that track from its beginning.

If you want to know the time modes in term of track number and elapsed time of the current track, or total remaining time on the disc, or total remaining time on the current track, those functions can only be accessed by means of the TIME/MODE button on the remote control.

In like manner, if you want to play randomly from a specific disc, or a full random play involving 250 tracks (selected at random), then those functions are only available by means of the RANDOM control button on the remote control.

If you want to repeat all tracks on a disc, then that function can only be selected utilising the REPEAT button on the remote control. Similarly if you wish to select the same track to repeat continuously, that function can only be selected using the remote control.

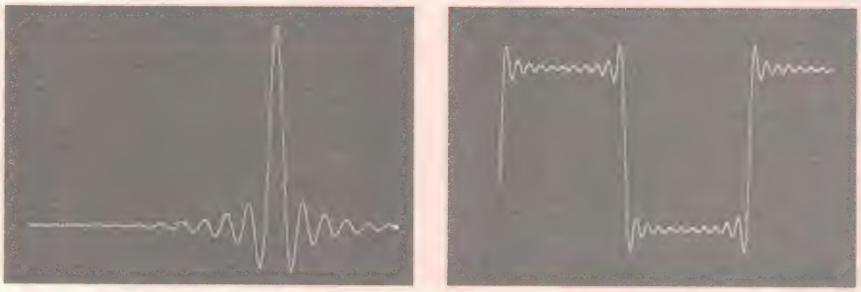
Using the pushbuttons on the front panel or the remote control, you can clear a single item from the program memory, but you can add tracks to the CD changer's memory from its front panel.

Although at first sight the SL-MC400 may appear slightly more complex than your existing or previous CD player, don't be daunted. It is very simple to use, and once loaded, is easier and more straightforward to use than most other multi-player CD changers.

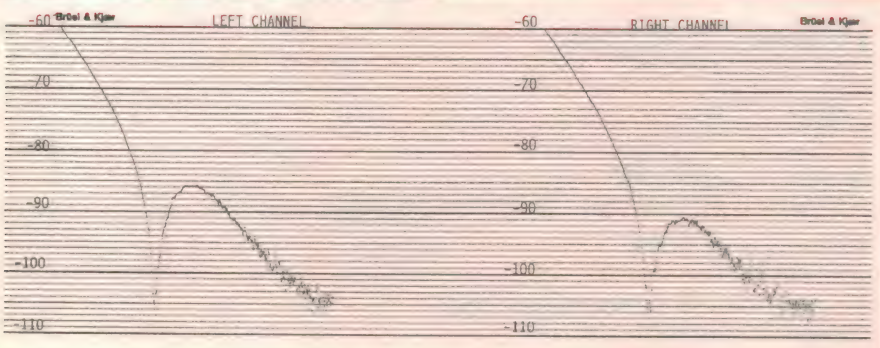
The front panel of the SL-MC400 player swings down to reveal the CD storage compartments. There are no fewer than 110 of these — but loading and unloading is relatively easy, thanks to a built-in sliding guide.

An examination of the back panel reveals that it has a pair of colour coded RCA line output sockets, and a Japanese two-pin mains socket with matching mains cord fitted with a standard three-pin mains plug at its outer end.

IMPULSE RESPONSE / 1kHz SQUARE WAVE RESPONSE



FADE-TO-NOISE / LEFT & RIGHT CHANNEL



Objective testing

The objective testing provided a mixed bag of results. Some of those results were in keeping what I would have expected, whilst others raised my eyebrows, as I initially observed results for which there was no obvious explanation.

The replay frequency response of both channels was within +0.9/-0dB from 5Hz to 20kHz, which is in keeping with what one would expect from a top line CD player. The frequency response over the lower band from 5Hz to 1kHz is ruler flat. At the upper end of the spectrum the response displays a gentle rise of 0.9dB between 1kHz and 20kHz, and that rise is in part due to the digital to analog (D to A) filtering circuit associated with this particular one-bit processor.

The REPLAY linearity is faultless from 0dB to -40dB. However between -40dB and -80dB there is a slow but inexorable increase in nonlinearity. The deviation manifests itself as a downward droop, which is typically -3dB at -80dB in both channels. Between -80dB and -90dB the magnitude of that nonlinearity and the shape of the curve blows out to -13dB. A change of nonlinearity of that magnitude is significant, and impacts on other parameters as I subsequently discovered.

I was initially perplexed by that -13dB change in nonlinearity, and wondered whether I hadn't made a mistake. I carefully re-ran the test with a separate test disc, but got virtually the same results. It was at that point that I decided to invoke a more incisive test, and reached for a test disc which contains a 'fade-to-noise' test track. That track provides a signal

which uniformly drops the signal level of a 500Hz test tone from -60dB down to -110dB.

As I plotted the test result, I was even more perplexed, as the shape of the graph is most unusual. After the output signal drops off to approximately -105dB, it then resurrects itself, in what I would liken to 'a little pirouette', as it climbs up to -85 or -90dB (depending on which channel you are looking at), and then drops away rapidly to -105dB with significant levels of residual noise.

Examining the curve, I frankly had considerable difficulty reconciling what I saw with what I have come to expect in this 'fade-to-noise' test. It was at that point that I rang up Mark Powderly at Panasonic Australia Pty Limited, who had been kind enough to provide the changer for review.

I asked Mark if he could ask his principals in Japan if they could explain the underlying reasons for this unusual characteristic. For good measure I faxed him a copy of the curves, and waited patiently for his response.

I was pleased that the response was prompt. More importantly, it was honest. Matsushita's technical laboratory in Osaka acknowledged that what I had observed was indeed a minor design fault. It appears that the A/D converter's earthing stability results in a non-linearity when it is subjected to very low signals, and particularly so when the signal drops below the -85dB to -90dB region.

Having acknowledged the presence of the fault, Japan also acknowledged that they were in the process of rectifying the design defect. Future SL MC400 units being sent to Australia should therefore not exhibit this particular fault.

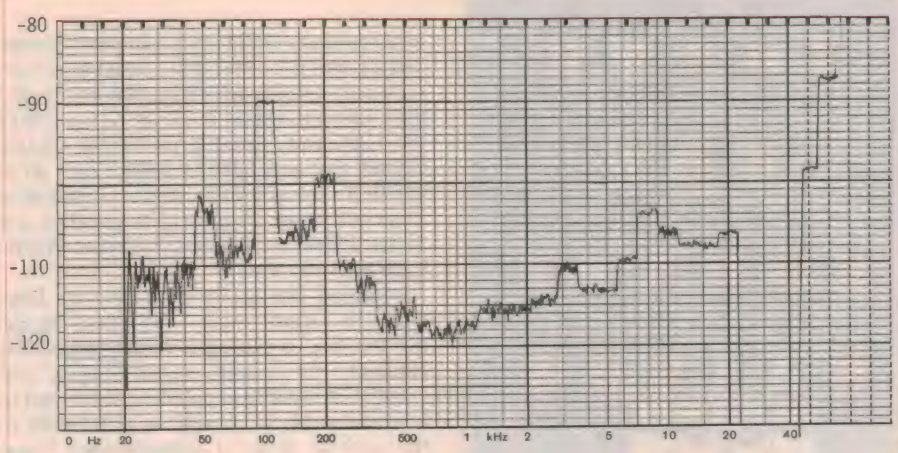
I proceeded to distortion tests, and noted that with test signals down to -70dB the distortion is acceptable. However at -80dB the distortion is unacceptable, and at -90dB I measured the highest distortion of any CD player which I have ever tested. The distortion components exceeded the magnitude of the fundamental signal on the test disc. That result was not particularly surprising.

Notwithstanding the magnitude of those distortion products, we are of course talking about signals so low in level that you are unlikely to ever to be able to detect them even with the volume control of your amplifier set to maximum output. In fact although the low level distortion figures do look atrocious, I later found that my test panel and I had the greatest of difficulty in detecting the distortion components with special demonstration software designed for that purpose. Even then the audible results were different from what I thought they might be.

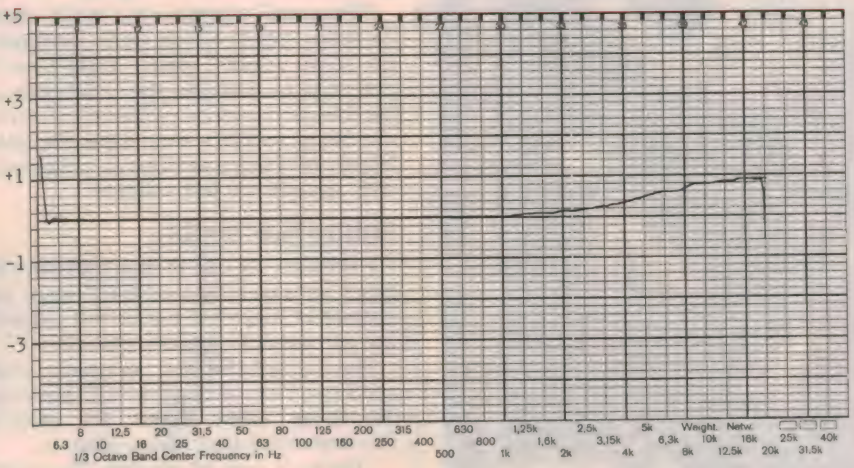
The normal signal-to-noise ratio performance of the player is excellent. Notwithstanding, I noted the presence of very low level RF signals superimposed on the audio output, which were detectable when replaying low level test signals into a cathode ray oscilloscope.

I progressed to the squarewave tests and

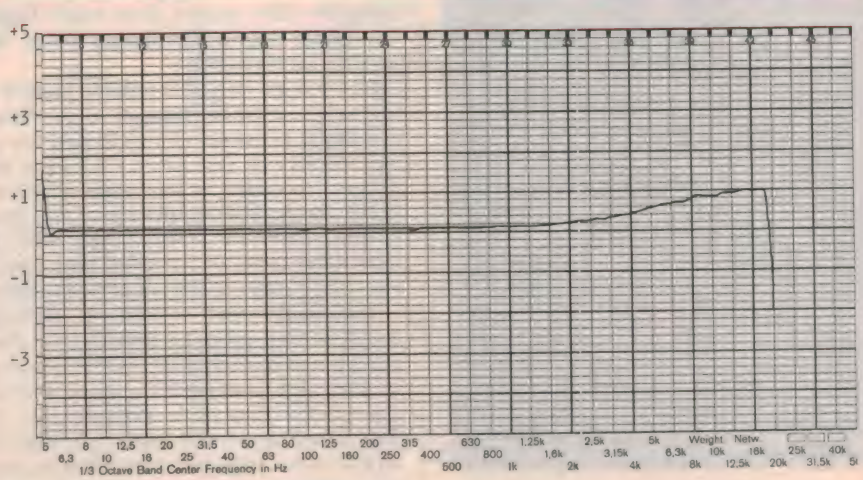
1/3 OCTAVE BAND SPECTRUM OF RESIDUAL NOISE



FREQUENCY RESPONSE / RIGHT CHANNEL



FREQUENCY RESPONSE / LEFT CHANNEL



impulse tests, which gave excellent results. The SL-MC400 exhibited a level of uniformity and stability which I could not fault. I then subjected the CD player to the DIRTY RECORD tests, BLACK DOT test, BLACK STRIPE test and FINGER MARK test, all of which it took within its stride — providing a performance which was as good as any of the $1000 to $2000 CD players which I have recently tested.

I placed the CD player on our large vibration shaker table, and even though the test disc is played vertically inside the changer, the system coped happily and without complaint even when subjected to a vibration signal as high as 0.3G RMS in the vertical plane. I acknowledge I was most impressed by the results of that test, as I had doubted the player's ability to cope with such a demanding requirement.

One of the last tests was the frequency accuracy of the reference oscillator, which gave a reading 27.75Hz high (+0.14%) for the nominal 20kHz test signal.

The overall objective test results included some results which were outstanding, but some which I feared might have the potential to degrade the subjective and audible performance of the unit. The obvious thing to do was to take the player home and listen and observe its behaviour with appropriate test material.

Subjective testing

I decided to call in my subjective test panel, as I was convinced that I would need competent support to ensure that the testing was fair and not singularly subjective.

The first test disc that we used to evaluate the performance of the CD player was the Sony 'SBM Super Bit Mapping Demonstration Disc' (Sony SBM 1).

Tracks 9 and 10 on this disc contain very low level signals (whose typical recorded levels lie in the range -80 to -90dB). The first track has 16-bit rounded signals. The next track has the same material, but with the signals re-processed using the SBM system. Both tracks feature the gentle sound of running water with remote wind chimes.

I turned my amplifier volume control up to maximum level (enough to produce a test signal in excess of 115dB had the signal been a 0dB test tone). Of course with a signal recorded in the range -80dB to -90dB, the audible output signal was down in the -25dB to -35dB range, with my head (and those of the other members of the panel) close to the monitor speakers.

The results were interesting. Although the distortion products should have been readily audible, because of the curvature of the D-A converter's output linearity curve, the distortion components are diminished at a more rapid rate than the fundamental. We were immediately aware of a softer (quieter) signal from the SL-MC400, when compared to my normal CD player. There was however no subjective increase in distortion.

We were aware of a slight increase in residual noise, albeit with the amplifier volume control set to maximum output. That test could not however be described as a normal listening test, in the sense that it does not replicate what you would hear when playing normal music.

We progressed to more conventional material, the first being two new discs from Placido Domingo entitled 'Bajo El Cielo Espanol' (Under the Spanish Sky), (Sony S2K 62625). This is a particularly fine set of discs produced in 1996, incorporating SBM processing supplemented by outstanding recording technique. We played these two discs through both my normal CD player and the SL-MC400, and simply could not fault the CD changer's performance.

What impressed us was that with 25 discs stacked in the changer, the time change from one disc to the next disc was less than 9 seconds — and the time change from one end of the stack to the other was still only 11 seconds. I sincerely doubt that any other CD changers on the market could equal or better these times.

With singing or vocal content, I could not fault the SL-MC400's audible performance. We progressed to a range of classical music and specifically Baroque. We played a new album entitled 'Baroque Bouquet' (Sony Classical S2K 62819), which incorporates an outstanding potpourri of music including Glen Gould playing Bach, E. Power Biggs on the organ, Eugene Ormandy and the Philadelphia Orchestra and William Bennet on the flute. Each provides appropriate music to evaluate the CD changer's fundamental performance with signals at both high and low levels.

As hard as we tried, we simply could not fault the CD changer's subjective (audible) performance. We auditioned a wide range of other test and demonstration discs, which encompassed music from rock to pop and from jazz to jive.

Summary

Frankly we formed the view that the SL-MC400 offers superior speed and unquestioned operational panache. With the prospective changes that the Technics' R&D group will incorporate in the future production versions, you would be hard pressed to find a better CD changer.

With a capacity of 110 discs, supplemented by its ability to play single discs in the conventional manner, the SL-MC400 is a sure-fire winner.

The dimensions of the SL-MC400 are 430 x 170 x 387mm (W x H x D), and it has a weight of 7kg. The quoted RRP is $999. Further information is available from Technics dealers, or from Panasonic Australia, PO Box 505, Frenchs Forest 2086; phone (02) 9986 7400 or 13 2600. ❖

Inside the Dick Smith Electronics 'PowerHouse':

A NEW CONCEPT IN ELECTRONICS STORES

In late August, Dick Smith Electronics expanded its well-known retail and distribution chain with a much larger and entirely new 'concept' store: the PowerHouse, in the south-western Sydney suburb of Bankstown. A few weeks ago, *EA*'s editor was able to pay a visit the new store and find out for himself what's so special about it. Here's what he found...

by JIM ROWE

Like most of *EA*'s readers, I guess, I was aware that Dick Smith Electronics had opened a new and larger 'concept' store, in Bankstown. We ran a news item on the opening in the October issue (page 107), although I hadn't actually been able to get out there at the time, due to a health problem. It wasn't until a few weeks ago that I was finally able to find time to visit the PowerHouse and see what it's actually like.

To be honest, I wasn't prepared for what I found there. To invoke a rather over-used term, it was quite a 'mind blowing' experience, even for this somewhat jaded and time-worn editor.

The press release from DSE had made a point of stressing that the new store was *not* simply an enlarged version of the company's existing and now-familiar stores — that in contrast, it was a whole new concept in electronics retailing. But then, they'd have to say that, wouldn't they? I automatically discounted the 'hype', and assumed that the new store was probably a cross between an existing Dick Smith Electronics store and one of the newer 'warehouse superstores', with acres of products on racks, almost no staff to be found and a 'you find it and lug it back to the checkouts, we'll take your money' approach...

Boy, was I wrong. Yes, it's a lot bigger than the typical Dick Smith store that we're all familiar with, and with many more stock lines. And yes, there *is* a row of supermarket-style checkouts where your purchase is finally processed. But that's about as far as the 'superstore' analogy goes, because the DSE PowerHouse has taken the concept a lot further — and in a much better direction, it seems to me.

For a start, there's certainly no shortage of sales staff. Although the

DSE's PowerHouse

PowerHouse is about 6-8 times larger than a traditional Dick Smith store, if anything the staff has been enlarged by an even larger factor. And unlike many of the sales people you find in traditional electronics browngoods retail/discount outlets, these people do indeed know their products. In fact DSE has picked many of their best and most experienced sales people from stores all over Sydney, to make up the new PowerHouse team.

Quite apart from this, though, the whole emphasis of the PowerHouse store seems to be in a direction quite different from the 'discount warehouse' approach. Instead of expecting you to have worked out exactly which product you want, in advance, Dick Smith Electronics seems to have put a great deal of effort into actually helping you make an informed buying decision. They've done this by providing not only well-trained sales staff, but also the facilities for customers to try out a wide range of products 'live', for themselves.

It's a concept that may not be new, but definitely has advantages for we customers — especially when we're contemplating the purchase of today's increasingly high-tech items. Sad to say, though, it's also a concept that many retailers have long since scrapped in their efforts to survive in a highly aggressive marketplace. All credit to Dick Smith Electronics for bringing it back to life!

Here's a just few examples of what I mean. In the Communications area, you can try out virtually every model of fax machine on offer — sending a fax back to your office, if you wish, and even getting your office to send back a test page to a machine so you can check its receive quality. The same applies to cordless phones, answering machines and so on.

Right: Before buying a fax machine or printer, you can try them out for yourself. Shown on page 33 is the Internet Bar, while below is the 'home theatre' demonstration room.

Similarly in the Computers area, you're welcome to test any of the desktops, laptops, printers, scanners, modems and other peripherals.

Much wider range

By the way in both these areas, there's a much wider range of big-name brands and models than is found in existing Dick Smith stores. In the Computers area the range of software is also much larger. In fact it's larger than the majority of dedicated computer stores, and really quite staggering. (The new store has its own on-site buying department, separate from DSE's existing department.)

To help people pondering whether they should buy a computer capable of 'surfing the Net', or what they'd use it for, there's even an 'Internet Bar' near the Computers area, where you can sit down and quietly 'explore cyberspace' for yourself.

Oh — and also an area where you can compare the performance of a variety of multimedia computer speaker systems. Yet another area close by allows you to compare the sound from various car sound systems and speakers...

Of course one of the big differences between the PowerHouse and ordinary Dick Smith stores is its much wider product range. As well as all the traditional products, there's a wide range of TV sets, VCRs, camcorders, hifi systems and amplifiers — plus a good range of pre-recorded videotapes and audio compact discs. In fact this part of the PowerHouse is very reminiscent of the consumer electronics department of a high-end department store.

Here again, though, there are some important differences. For a start, there isn't the usual bewildering array of umpteen different brands and models; instead DSE's buyers have made a careful selection, and present a reasonable range of brands and models with features that are often complementary. In TV receivers, for example, there are

about four choices of small-screen 'personal' set, four medium-sized sets, four large-screen stereo models and a couple of widescreen models. And you can see how each one performs, either off-air or playing a videotape or Laserdisc.

That brings me to the demonstration rooms. These are two of the most impressive features of the PowerHouse store, with one dedicated to hifi amplifiers, receivers and speaker systems, and the other to 'home theatre' surround sound systems. Both have systems to allow fast and convenient switching between a variety of signal sources, amplifiers and speaker systems, for easy 'A-B' comparisons. The home theatre demo room also has a large-screen TV, the ability to try a variety of rear-channel speakers and subwoofer systems quite separately from the main speakers, and the ability to play material from Laserdiscs as well as videotape. Very impressive!

Trying out one of the PowerHouse range of name-brand camcorders.

The technical section

But has all this dramatic expansion and enhancement of what we might call the 'consumer electronics' section of the PowerHouse been at the expense of the traditional DSE emphasis on components, kits and equipment for the technician, hobbyist and amateur radio enthusiast? Not at all, as it happens. In fact the 'technical' part of the PowerHouse is also very impressive, and probably by itself larger than the majority of DSE's traditional stores.

This area too isn't just larger, but has been enhanced as well. There's a larger range of test instruments, I noticed, and a very impressive area with built-up and working demonstrations of many of the more popular electronics kits — including DSE's own Funway and Discovery kits, of course. Each weekend there's apparently even a live demonstration of kit building, to show kids and their parents how easy and rewarding it can be.

I also found a very impressive 'Ham Radio Shack', where radio amateurs and would-be amateurs can try out equipment for themselves on air. There's an impressive array of antennas on the roof of the PowerHouse, to ensure that everything works properly.

Another great feature in the technical section is a quite respectable reference data section, stocked with a range of data books from many semiconductor makers and other component manufacturers. It even boasts a photocopier, so you can make copies of the data you need and take it home. Why didn't somebody think of this before?

There's also a small service department on site, with technicians who are able to make minor repairs and also perform various on-the-spot upgrades to computers — like expanding the memory, adding drives or cards, and so on. And a fitting bay at the rear of the store, where car radios and mobile phones can be fitted...

By the way, the PowerHouse also includes a Telstra kiosk, where customers can try out and buy a range of cellular and traditional phones, and also see what's available on Foxtel pay-TV.

Well, have I given you more of an idea of the differences between the new PowerHouse store and existing DSE stores? I hope so, although the full impact of what DSE has achieved with this new development probably won't hit you unless you do what I did, and spend an hour or two walking around it yourself.

Spend a couple of hours walking around an electronics store, I hear you ask? Yes, it might sound strange — but then, the PowerHouse is no ordinary electronics store. To me, it's a very impressive development in electronics retailing, and because of the extra benefits to customers I really hope it will be such a success that DSE will be motivated to build lots more of them.

If you'd like to visit the DSE PowerHouse, it's at Christies Home Centre, on the corner of Chapel and Canterbury Roads, Bankstown. Don't take my word for it, pay a visit and see for yourself. ❖

Moffat's Madhouse...

by TOM MOFFAT

From Teletype to E-mail (and love letters)

It's interesting to propel yourself back into the past a little way, and imagine how things were in the days before cell phones and fax machines and e-mail. How did we communicate then?

I think that in professional communications at least, the teletype machine ruled supreme. Remember them? I'll bet there are people out there (all you young pups) who have never even seen (or heard) a teletype machine. But as little as 15 years ago, they used to be everywhere.

Longer ago than I care to remember, I worked in the newsroom of GTV-9 television in Melbourne, which was considered the flagship of the Nine Network. As well as being an 'on the road' reporter, I spent many shifts working as Chief of Staff — sending out the news teams to cover whatever was happening, making sure they got their film back in time to process and edit it for the 6:30 National Nine News. (No video camcorders back then, folks!)

Not far from the Chief of Staff's desk was a large bank of teletype machines. These weren't the fancy European models; instead they were the original American-made machines dating back to the Second World War. Model 15's, for those in the know. These machines had one very distinct characteristic: they were noisy. I don't mean clickety-click-click, I mean BANG-BANG-BANG.

There were three of them as I remember, one carrying Australian Associated Press news, another with Age Radio News from the *Age* newspaper, and the third was used as a telex machine on which we sent news scripts back and forth with TCN-9 in Sydney. These machines spent every day and night banging and clattering away, and after a while they started to drive everyone nuts.

A television newsroom is a high-pressure place, and all the noise made the daily headaches more severe than ever. Some of us decided we just couldn't take it any more; something had to be done. Requests to the management weren't received too favourably, so it was time for some industrial action. We decided to have the teletypes declared a health hazard.

We managed to scrounge one of those professional sound-level meters, planning to prove beyond doubt that the teletypes would drive us deaf. But the machines didn't seem to generate a DANGEROUS noise level, just an IRRITATING noise level. Not a health hazard at all...

Eventually management got sick of all the whinging and had wooden cases built around the machines. This quietened them down a bit — not perfect, but we could put up with it. Eventually most newsroom teletype machines were replaced by dot-matrix printers. Instead of going BANG-BANG-BANG, these went 'Bzzzzzzzzzzttt! Bzzzzzzzzttt!' as each line of copy was sprayed onto the paper. Still enough to drive you up the wall. And nowadays? Computers, totally silent. Sweet relief!

I met the most amazing installations of teletype equipment ever, during a trip to Antarctica about 13 years ago. At that stage almost all communications to and from the continent, and across it, went by radioteletype. Morse code was still used sometimes, too.

Each Antarctic station had a large radio room with row after row of teletypes. By now most of the old Model 15's had gone to bang-bang heaven, to be replaced by slick Siemens models. Most of these machines had paper tape readers that went clickety-click as the machine's type bars went tickety-tick, if you get my drift. Get about a dozen of these going at once and you had a very strange symphony!

It seemed the radioteletype networks were used mostly for exchanging weather information. But they were also a much-loved link with home. When men went to Antarctica for long stays, communication with home was very difficult. Radiotelephone calls were outrageously expensive, but each week every expeditioner was allowed to send one telex home, consisting of no more than 20 10-character words. And families were allowed to send a similar message back...

So the Australian Antarctic Division developed a system of codes, each five characters long and each starting with 'W'. There were several hundred of these codes, each with a set meaning. for instance, 'WABCD' might mean "It is very cold and it has been snowing" or 'WYXYZ' could mean "I went for a long walk on the ice yesterday".

So it was possible to compose quite a long and detailed message when it could contain up to 40 of these five-character groups, joined into 10 as 'WABCDWYXYZ WDEFGWLMNO' and so on. Each expeditioner was given an 'Antarctic Code Book' to take with him, and the family back home also had a code book. The highlight of the week was the day these messages arrived, and everyone grabbed their code books to decode them.

These messages were commonly known as 'Whizzers', named after the most popular code, WYZZA. Its meaning was: "I miss you so very much, my darling." There was a blank page in the back of each code book where expeditioners and their loved ones waiting back home could construct their own *personal* Whizzer codes, prior to parting. Some of these were, how would you say... very explicit.

I guess those old Whizzers were one of the first kinds of e-mail. Now e-mail seems to rule the world. I shoot the stuff back and forth between the USA and Australia on a daily basis, absolutely free — once my Internet account charge is paid. And so many businesses nowadays rely on e-mail almost exclusively for their internal communications.

The company I work for, a large Internet service provider, probably uses e-mail 95% of the time, and the phone 5%. I get messages from the boss asking me to

work on some system software project, and I send back to him e-mails reporting how things are going.

Another e-mail network serves our telephone technical support system. Customers phone in to one central point, where a kind of 'Chief of Staff' e-mails trouble reports to the support people — who generally work from home with a computer and a telephone headset. When the case is completed, a report is e-mailed back to the originating point where results of each case are stored in a database. Pretty good, huh?

Sometimes my work with the big computer system requires that I make contact with someone else's tech support line — possibly a modem manufacturer or a network card supplier. Almost always, the information we require makes its way back to us by e-mail. It's probably been said before, but it really makes you wonder how humanity every existed without e-mail. I'm just glad I don't own shares in a post office; I reckon their days are numbered.

Rejuvenated writing

I've heard it said that the emergence of e-mail has rejuvenated the art of writing. Instead of just babbling mindlessly on the phone, people once again sit down and put pen to paper — figuratively speaking. I myself find it much more useful to write an e-mail report to the boss, explaining exactly what I have been doing on a project, what problems have cropped up, and what I intend to do about those problems. It's a lot easier to do that in your own sweet time rather than trying to come up with answers on the fly, the instant the phone rings.

I'll bet you didn't realize that the ascent of e-mail has caused a re-birth of one of the oldest forms of writing: the love letter. No longer is it necessary to try to corner some lovely co-worker at the coffee urn. Now you can type up some appropriate words on your computer, address them to her desk clear across the room, and press the SEND button.

Zap! An on-line virtual flirt hits her right between the eyes. In the early stages she might not even know who the message is coming from. Good. Let her imagine you are a fine young hunk with a way with words. If you are good enough with your words, you've already got a head start — even if in real life you're fat, old, and beat-up.

This thing isn't foolproof, though. Pick the wrong target for your flirty e-mails and you'll cop a sexual harassment charge. It happens. I've read about cases in the newspapers several times.

Since Christmas is nearly upon us, let me tell you a nice story. This involves a man and a woman working at a company near Seattle. Discretion is important here, so I won't identify them, other than to say they *don't* work for Microsoft and they don't work for the government. That should keep them out of trouble.

The man and the woman were both recently divorced after fairly long marriages. Both were middle-aged, both had lots of kids, and both had long ago lost the art of courtship; they'd never really thought they'd need it again.

One night, at a social function, they kind of spotted each other. Didn't say much, just looked. Next day they were back at work seated in front of their respective computers. And then, the first message flashed along the network — just a tentative "hello". And the answer went back — "hello to you too". The fuse was lit.

Every day, in the course of company business, the man and the woman would find time to sneak in a few 'unofficial' messages on the side. Kind of illicit. Kind of naughty. Kind of exciting. And it wasn't long before there came an invitation to dinner, from the woman. At this stage they had spoken barely two words to each other, and never spoken on the phone. Just the e-mail.

The night was successful, given that both these people were at this stage pretty shy of the opposite sex — neither had been on a 'date' in over 20 years. But they did get to sit together, and look at each other, and *talk* instead of type.

Both agreed that it wouldn't be to wise to spread word around the office about their blossoming romance (and here I use the word 'romance' deliberately, instead of the politically correct 'relationship'). So they pretended they were 'just workmates', nodding as they passed in the office, otherwise ignoring each other as they moved back to their desks. Then it was e-mail time.

Love letters were invented in the first place because it is sometimes easier to express just exactly the right words in writing, rather than blathering off the first thing that comes into your head. By now our man and our woman were spending more than a little unauthorized computer time, thinking up just the right words, and thinking of each other.

You have to picture this — they walk past each other in the office, putting on a perfect act of indifference, although slightly tainted by some more-than-just-friends glances. But once back at their computers the network cables start to sizzle. All this coming from a couple of oldies on the wrong side of 40!

As this was being written, that e-mail romance was still under development, and going rather nicely.

If this thing is happening to two people that I know of, how much more of it is going on through the many thousands of workplace e-mail networks throughout the world? If Dick in Engineering and Jane in Accounts are spending so much of their time composing electronic love letters, could we perhaps expect Fred in Shipping and Sally in Marketing might be doing the same thing? You'd never know by just looking. Maybe it's going on all over the office; all over the world. Look around your own workplace — see any smoke coming from the e-mail server?

The interesting thing is that without e-mail, and the ability to sit back and carefully compose your thoughts, maybe our two middle-aged friends never would have got together. Remember, they were both very shy. Would they have ever got around to a first phone call?

Well, my friends, we kind of drifted away from electronics, but it is almost Christmas, and Christmas is about love. So I guess that story was appropriate under the circumstances. Best wishes for the season!

Editor's Note: Tom Moffat has asked us to point out that he is NOT the subject of the story in this month's column, despite references to 'fat, old, and beat-up' — any resemblance is purely coincidental. Mr Moffat says he was simply experimenting with a 'Mills and Boon' writing style, and that offers from other publishers would be gladly accepted. ❖

When I Think Back...

by Neville Williams

Maxwell Howden: Pioneering quartz crystal manufacture in Australia (2)

Having pioneered two-way amateur radio from Australia to the USA and Britain using shorter wavelengths (higher frequencies), Maxwell Howden turned his attention to the technology and production of quartz crystals. In due course, he became a major supplier to the local electronics industry, the Royal Flying Doctor Service and the Armed Forces.

Born in 1899, Max Howden became involved in radio at a time when the technology was based predominantly on sparks and arcs. It wasn't until around 1920, coincident with the re-emergence of the Wireless Institute of Australia, that Max and his fellow enthusiasts could abandon the old technology.

From then on, throughout the 1920s, enthusiasts tended to concentrate on emerging valve circuit configurations, with some receivers distinguished by fancy names: e.g. 'Philips P1', 'Marco 4', 'Browning Drake' and so on. Others represented departures in basic circuit principles: multi-stage TRF, neutrodyne, superregeneration and super-heterodyne.

Max Howden was up to his ears in this technical scramble — except, it would appear, that he favoured simplicity with efficiency rather than brute force. He made special point of the fact that he had won the Transpacific competition using a humble three-valve receiver. What intrigued me, as I prepared this biography, is how he also found time to become so deeply involved in quartz crystals.

Modern crystallography, I gather, dates back to about 1912, when it was discovered that crystals could be identified and analysed by X-ray diffraction; this along with the so-called piezoelectric effect, by which certain crystals — e.g. quartz — were shown to change their dimensions when subjected to electrical stress. The reverse proved also to be true: when stressed mechanically, some crystals produced an EMF between certain faces.

In practice, piezoelectric crystals found little application in wireless/radio communication during the aforementioned 'arcs and sparks' era, having to await the emergence of valve technology — and thereafter grow with it. The question was, when and how?

Max Howden in his prime, through the eyes of illustrator L.F. Reynolds. Writer C.R. Bradish suggested that, for someone who so often devoted the wee small hours to long distance radio, shaving was an unacceptable intrusion!

Early knowledge

Looking back through my original 1931 copy of the *Admiralty Handbook*, I came across a segment on quartz crystals, cheek by jowl with traditional (and obsolete) Royal Navy wireless technology. It explained how crystals could be cut and ground to produce a wafer exhibiting an electro-mechanical — or piezoelectric — resonance effect, at a selected frequency within the RF spectrum. Furthermore, if such a crystal were used in a valve oscillator stage in place of the usual L/C resonant circuit, the valve would oscillate at the natural piezoelectric frequency of the wafer. More to the point, the slab would behave as if it had a 'Q' factor (or 'selectivity' curve) far superior to that of any conventional L/C tuned circuit, such that the oscillator would be effectively locked to the frequency for which the crystal had been ground.

Searching further through early references, I came across my 1936 copy of the *ARRL Handbook*, with text that had originally been revised and updated by Ross Hull, an expatriate 'Aussie' and a Melbourne amateur, who would have associated with Max Howden in the 1920s.

The *ARRL Handbook* illustrated the shape of a natural quartz crystal, explained its inherent structural axes, and the special slab 'cuts' which could be exploited to minimise the effect of temperature on its resonant frequency.

The writer went on to stress that special equipment was required to identify the axes of any given crystal, and to cut suitable slabs for subsequent grinding. The techniques and skills involved were confidential to the manufacturers.

Described by then staff member Ian Pogson in the June 1978 issue, this simple Crystal Checker was used to check the author's collection of vintage crystals — mainly in FT-243 packages.

Typical blanks were about one inch (25mm) square, with variants somewhat smaller and of rectangular shape.

Few amateurs, he added, attempted to cut their own blanks, preferring to buy pre-cut -X, -Y or -AT blanks which they could then proceed to grind into functional crystals. At the time this was a table-top exercise calling for fine grade carborundum powder, an offcut of plate glass to serve as a bed plate and a generous helping of time and patience.

An accompanying diagram showed the relationship between the thickness of typical blanks and the fundamental frequency. Amateurs attempting to grind their own crystal could use a micrometer to check progress and flatness, but a test oscillator and a calibrated receiver was essential to keep track of the precise frequency.

A decade earlier!

But this was in 1936. One could only boggle at the notion of Max Howden, the best part of a decade earlier, and with little to go on, attacking a lump of glass-hard crystalline quartz with carborundum cloth wrapped around the blunt side of a hacksaw blade!

Little wonder that he settled instead for a diamond saw, while Jock Howden looked on, wondering whether his younger brother had taken leave of his senses...

In fact, Max was not simply following the lead of other enterprising amateurs; he was working things out the hard way and gathering information which would be disseminated to other enthusiasts, over the air and via handbooks and magazines.

Some of his early observations about crystals were published in an article in the American ARRL magazine *QST* for November 1929, headed: ***EXPERIMENTERS' SECTION — New Crystal Fragments, by Maxwell Howden VK3BQ***.

It took me a while to work out that he wasn't referring to fragments of crystals, but to new fragments of information about crystals.

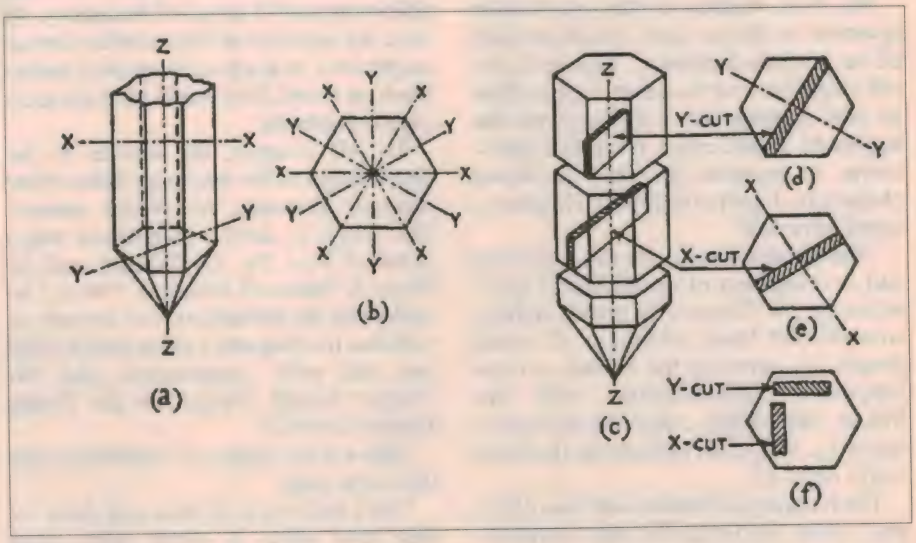
Max remarks that relatively few American amateurs seemed to be opting for crystal control — possibly because, over and above the cost of the crystal, the associated circuitry suggested in ham literature was often needlessly complicated.

In Australia, by contrast, the interest in crystal control was proportionately much higher. Much of the crystalline quartz came from the Mount Lofty Ranges near Adelaide, and amateurs ground their own, mostly for use in the 3.5MHz (80m) band.

A simple single-stage transmitter comprising a 201A triode, crystal controlled, could distribute a Morse Code signal across Australia and New Zealand, representing roughly the same area as the USA. Add a single 210 or two in parallel as a power amplifier, and there would be power to spare.

The essential difference between the two countries was the amount of interference in the USA arising from the huge number of active amateurs in that country. In that environment, power output seemed more important than stability!

Max then goes on to detail his observations when grinding crystals for the 3.5MHz band. It was not at all unusual for a crystal to oscillate in harmonic mode, as distinct from the desired frequency. The unwanted mode could often be either reinforced or suppressed by selectively grinding the corners — or making the chip, overall, ever-so-slightly concave or convex. Mention is also made of the energy level applied to the wafer, and the possibility of causing the



The physics of a quartz crystal as presented in the ARRL Handbook for 1936. Max Howden was struggling to come to terms with all this when he told of his experiences in an article in QST, for November 1929.

crystal to puncture or even shatter if over-excited.

Published back in 1929, the content is far too 'fragmented' to summarise or to qualify as 'How to' reading. What it does signify is the amount of time Max must have devoted to grinding crystals in the late 20s, putting him in an advantageous position to supply blanks cut to specified axes, and/or wafers and holders ground to specified frequencies. In short, practical experience gained as an amateur in the late 20s and early 30s opened the way to a career as a manufacturer and supplier of crystals, in the decades that followed.

Crucial visit

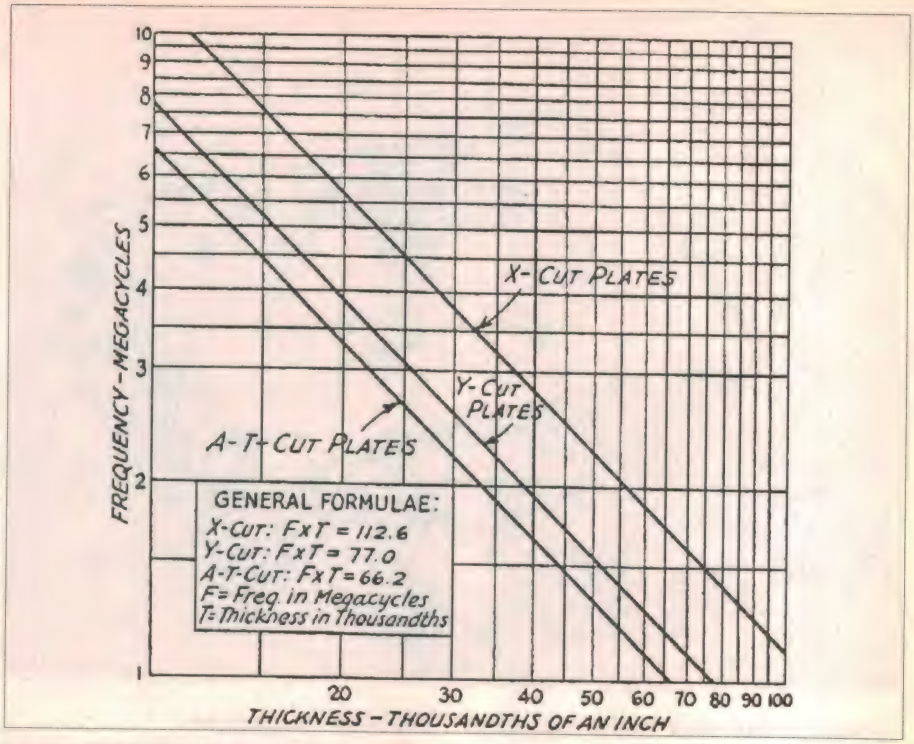
As mentioned in the last issue, one of the very early challenges to supply finished crystals on a semi-commercial basis came with a visit to his home by Alf Traeger and Dr John Flynn of the Royal Flying Doctor Service. The RFDS faced the problem of providing wireless communication with lonely cattle stations and outposts dotted over the vast interior of Australia. In the event of an emergency, there could be no assurance that such equipment had been maintained in the interim or that a knowledgeable person would be on call to operate it.

Alf Traeger, with the help of fellow amateurs like Wally Coxon, came up with a transceiver powered by a generator, driven by pedals in the manner of an exercise bike. Almost any one could provide the necessary energy — adult or child, male or female, black or white.

The first version of the transceiver operated on Morse code, which presented an obvious limitation. Traeger's initial response was to adapt a typewriter so that tapping out a message on the keyboard would cause the pedal transceiver to transmit the text in Morse characters. I quote from Max Howden's taped interview:

"The greatest step... was the designing and development of an automatic typewriter by Mr Traeger, by which laymen who did not know Morse at all could simply, by pressing the buttons on the typewriter, automatically send the Morse code replica... with the necessary spacing... so that an operator at the Base could copy it."

The reliance on Morse code was obviated when the Pedal Set was re-developed for telephony, making it possible to communicate by word of mouth. There remained, however, one major



Also from the 1936 ARRL Handbook: intended purely as a guide for hand-grinding crystals, a plot of wafer thickness against frequency for X, Y and AT cuts.

limitation: namely that of frequency stability. Transmitters throughout the system relied on conventional tuned L/C circuits, which could be moved off-channel by mishandling, temperature changes, or variations in the supply voltage — any one, or all three!

The pedal sets posed a special problem in that the effective supply voltage depended on the inclinations of the person doing the pedalling. They might pedal fast or slowly, or an erratic mixture of both — with the RF oscillator following suit in terms of frequency. At best, the operator at the receiving station might have to keep nudging their tuning knob; at worst, they might miss the message completely.

To Alf Traeger, the answer to the problem lay in the emerging focus of the amateur fraternity on crystal control. The result, as already mentioned, was a personal visit by Alf Traeger and Dr Flynn to Maxwell Howden: "Would he undertake the manufacture of crystals to stabilise the frequency of up-dated pedal sets and other transmitters, that Mr Traeger would design for the Flying Doctor Service?"

This was his reply, as recorded on the interview tape:

"So I undertook it then and there — and have done it, along with other things, ever since."

At that point the transcript of the taped interview ended, leaving me to speculate what Max had meant by 'along with other things'. In the temporary absence of John Howden, I managed to contact his brother Arthur ("call me Bill"). While acknowledging that John was the better informed about family history, 'Bill' confirmed that his Dad had never abandoned his amateur status, but had simply 'put on his commercial hat' to the extent that it became necessary, following his committment to the RFDS.

(From W. Scott McPheat's book on John Flynn, I learned that by 1939 the number of pedal sets in use in the outback was about 150, mostly grouped in clusters around 'mother' stations. In those days, that would certainly have been enough to get Max started!)

Family business

Said Bill: "Dad had always operated from his home address. When his activities outgrew the space available in the house, he had built a workshop/factory in the backyard where he managed to accommodate new technology and rising demand."

At times, his 'staff' comprised mainly family members. During the war, the backyard factory housed people assigned to him by the Manpower Authorities, plus technical visitors from the various services.

In the early days, Bowden crystals were hand-ground and comprised a hor-

izontal metal platform on a spike, supporting the flat crystal wafer. Another metal plate rested on top of the crystal, with a flying lead for connection into circuit. These gave way to a more homogenous vertical assembly, with the crystal supported lightly between two metal plates in a shell measuring about 1-1/4 x 3/8 x 1-3/8 inches (D x W x H), with pins about 3/4" apart. Then came a scaled-down version with pins about 1/2" apart, and an even smaller and more rugged type around the time of WW2, commonly described as FT-243.

Questioned about technology, Arthur said that his father used plain old-fashioned hand-grinding to produce his earliest crystals using a slab of thick plate glass with coarse, then fine grain, carborundum powder. It was slow and tedious work.

Later, he invested in a lapping machine, in which a dozen or more slabs could be held in slots in a flexible spacer plate so that they would be ground down more or less uniformly. This done, the individual wafers would be hand-finished separately to the required frequency.

"Did he use acid etching?"

"He tried everything!"

"What about the technique of plating crystals, rather than mounting them between separate metal electrodes?"

"Plating? Well, Dad was certainly into the deposition of silver in a vacuum chamber. They would watch the resonance falling as the deposition progressed, and stop it at the right moment."

"That sounds as if he was using a digital frequency standard".

"He certainly was. Dad was well and truly into digital technology. He worked until he was in his mid '70s, and while he had younger people working for him, he was well up with what was going on. Dad may have become a professional, but he was still an amateur right up to the end!"

My thanks to John and 'Bill' Howden for their help in fleshing out the 'big picture' of their father's career.

A FINAL TRIBUTE

Amateur Radio magazine for October 1983 contained an article by Maxwell Hull VK3ZS, reminding readers that the issue represented the 60th anniversary of the magazine itself, as well as worldwide two-way communication by amateurs on the officially 'useless' shorter wavlengths.

It was also an appropriate time to recall the contribution of the late Walter Francis Maxwell Howden: Permit 19 - Permit V140 - 3BQ - A3BQ - OA4BQ - VK3BQ.

Then followed a summary of Max Howden's career and his very considerable contribution to the communications industry, and to the Amateur Movement in particular.

Featured was a drawing by L.F. Reynolds with the following caption:

'A curious man, with a face paled by long vigils and by eyes lighted by the fanaticism of one who had dedicated life to a passion. The techniques of wireless slip off his tongue as the prayers of a Buddhist monk, and I doubt if he has, in recent years, mentioned any other subject with animation. He had the strange gift of concentration on one thing, which marks men of high talent.

Vale Max Howden, VK3BQ, 18th May 1980.'

Personal memories

Finally, a personal word. I first became actively aware of Max Howden after the war, when expeditions to Prices Radio, ACE Radio and similar firms turned up oddments of war surplus equipment containing plug-in crystals, usually of the larger variety described earlier. Branded variously AWA, RCA and Howden, they had one thing in common: their marked frequency never coincided with an amateur band!

However the magazine's then Editor, the late John Moyle, taught me that the 'next best thing' was a reputable crystal ground for a frequency comfortably *below* an amateur band. Give him a free evening and a new record album to entertain his ears, and he'd move the resonance up into the adjacent amateur band...

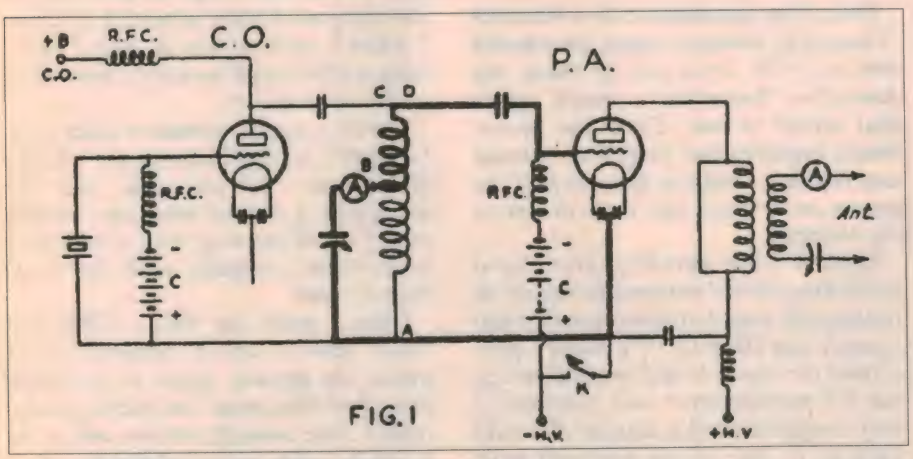
As it happened, John had picked up a military wavemeter using a simple battery powered type 30 triode, and a precision tuning capacitor and finely calibrated dial. Calibration involved listening for heterodynes with signals from commercial stations of known frequency, and plotting the dial readings in a graph book. By using harmonics as well as fundamental carriers, it was possible to pinpoint a wide range of frequencies.

John Moyle had also scored a handy lump of plate glass 1" thick, quantities of carborundum powder and hydrofluoric acid in a plastic container. My mental picture of relaxation at the time was John Moyle with all this set up on the dining room table, with a gas fire, a pipe and a classical album as interpreted by an Ortofon pickup, a Playmaster amplifier and twin Wharfedale loudspeakers...

It was little wonder that John Moyle was never short of a crystal, or that members of the *R,TV & H* staff rarely ground their own. Why would we, when John Moyle gained so much pleasure from guiding otherwise useless blanks to a new target frequency, with 'a rub here and a rub there' to optimise the activity...

During a recent sort-out of my career left-overs, I came across a transistorised crystal checker and an assortment of reference crystals that reminded me of the Howden era: 1MHz, 2MHz, 3MHz, and so on. They're mainly in the FT-243 package and huge by modern standards, but they were highly valued at the time.

Having summarised the life story of Max Howden, it is easier to understand his lifetime fascination for those crystalline slabs. What fascinates me nowadays is the number of crystals which regulate even the least expensive clocks and watches, with an order of accuracy measured in minutes per year! ❖



In QST for November 1929, Max Howden gave this circuit for a 'keep it simple' 3.5MHz transmitter involving a single common cathode 201A oscillator, plus a 210 power amp (as shown) or two 210's in parallel.

THE SERVICEMAN

The theatre organ that wasn't too keen about living by the seaside...

This month we have another story about servicing an electronic organ — a large 'theatre' type, a bit long in the tooth but solidly made, which became increasingly 'unwell' as a result of living too near the seaside. The story has a surprisingly happy ending, though, as you'll discover. We also have a nice tale about a junior serviceman's first serious repair job, which was also a great success.

Now, before you begin to accuse me of being a music nut, I assure you that it's just coincidence that this month's main story is about the same subject as one of last month's. I have no particular enthusiasm for electronic organs, but twice in two months contributors have come up with interesting yarns about servicing and maintaining these complex instruments. Who am I to argue with fate?

This month our contributor is Arthur Madden, from Narrawallee in NSW, and he tells of his long and frustrating efforts to repair his own organ. Here is what he has to say...

Before I go into my story, I should tell you I am not a serviceman as such. I am a electronics hobbyist and I do repairs only to my own equipment, and then only if I think I can handle it. I believe I have had a reasonable record of success in this respect.

I am also a player of electronic organs and have two of these monsters in my music room. These instruments are pretty reliable, but if you do get a fault, it costs big bickies to have a repair man come from the nearest large town.

Usually these servicemen 'save up the jobs' until it is worth the trip to do a number of jobs in a district, sometimes staying in motels while they finish off all the jobs in the area. So the cost of travel and expenses has to be paid, and this can make the service bill quite substantial.

Consequently, most times when a repair is needed it means a long wait, so an organ may stay 'out of order' for some time awaiting the pleasure of the repair man. Local electronic servicemen (TV, video, etc) are not interested in this type of repair, as it can be so time consuming — and think of all the additional service manuals that are very necessary.

One of my instruments is a Baldwin 'Cinema 2' theatre organ, purchased new in 1976. It is one of those big American 'horseshoe console' types that weigh a ton. Even the pedalboard requires two people to remove and replace. And you have to pull the organ away from the wall to get at the innards.

However, the circuitry, even for a fairly untechnical person like myself, is reasonably easy to follow. I was smart enough way back in 1976 when I purchased the organ to also write direct to the US manufacturer and purchase a very complete service manual. It would have to be one of the best and most complete manuals I have ever seen, and has saved me a great many dollars over the last 20 years.

I usually require a day or two with the manual to get my ideas of the fault into gear, before I tackle it. This organ has a section called 'Fantom Fingers' and it plays 'rhythmatic arpeggios' as a background. This can be piano, harpsichord, guitar, banjo or harp sounds. It also can be set to 'normal', so that each instrument can be played solo, on either upper or lower keyboard.

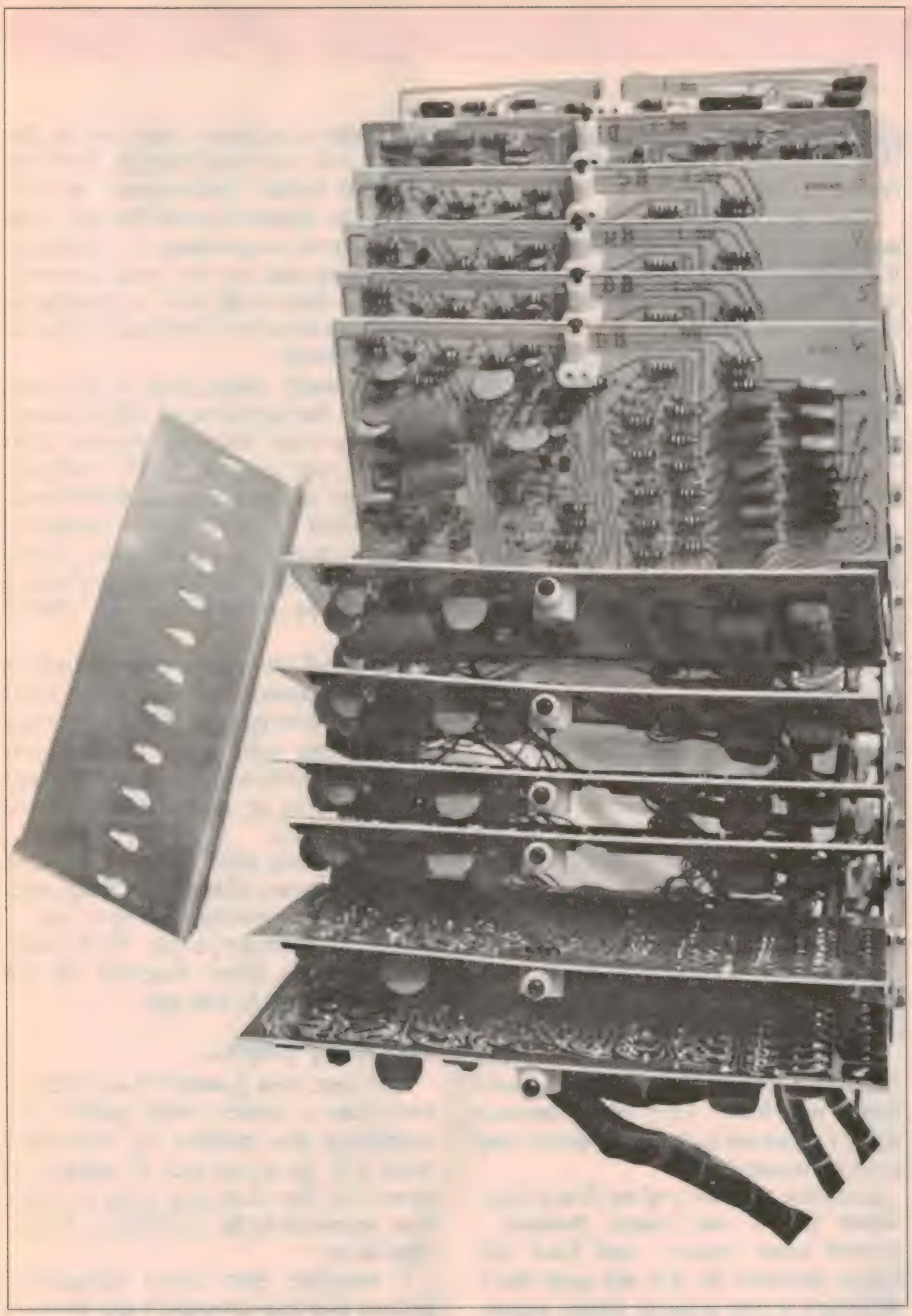
There are also three different modes that can be chosen such as normal, arpeggio (up) or arpeggio (up and down), plus strum and multitone. To achieve all of these functions there is a bank of no less than 12 circuit boards, each measuring 230 x 130mm.

The Fantom Fingers section failed first about 1992, and I was able to narrow down, quite successfully, the board number I thought was at fault. The individual notes would play, but the arpeggios would not fire up. As the components are basically standard capacitors, resistors and diodes etc, I went through a process of checking each item in turn. I told you I wasn't very technical and I don't have a CRO (and wouldn't know how to use it anyway!)

Needless to say, no matter what I did, I couldn't get it to 'arpeggi-ate'. As the organ was still playable, less the arpeggios, I put my mind into neutral until I could catch up with a very busy semi-retired computer tech that I am friendly with.

What's more, he has a CRO and knows how to use it. Between us we traced the missing signal to the board that I had designated. (At least I got that right!) Sure enough, we ran out of the signal we were tracing on that board.

After some inspection of components, with no result, we started again from where we had lost the signal. Suddenly



Taken from the excellent service manual for the Baldwin 'Cinema 2' organ, this photo shows the bank of boards used to provide the 'Fantom Fingers' functions. It was this section of contributor Arthur Madden's organ that gave trouble, and had to be replaced.

my friend yelled "Gotcha!" It was an open circuited track around the edge of the board. As I had the soldering iron on idle, I grabbed a short piece of hook up wire; the bridge was made, and all came back to life.

Bank of 12 boards

On closer inspection, all of the boards are installed 'track side up' in a bank of 12, with only about 30mm between boards. They are hinged together and can be folded up or down, so as to work on whichever board has the headache.

The significant thing is that the tracks are on top with the components hanging down underneath. At this stage, I should mention that I live quite close to the ocean. Imagine how unkind the salt-laden air is to these fine tracks...

Since then, almost on a regular basis, I have been busy tracing faulty tracks with my $30 digital multimeter. The lesson to be learned is that a very liberal coating of circuit board lacquer should be applied. It had never been done to these boards!

To be fair, an organ in an area away from the coast may never suffer this damage. But we do like to live beside the seaside, so we suffer the consequences!

When the first faulty track appeared, we inspected the rest of the tracks and they all looked OK. But two years later they opened up almost weekly, until finally I tried to source a supply of new boards.

This was impossible in Australia, at any reasonable cost. It was suggested by a few suppliers that I pull the boards out and have them copied and manufactured in Sydney, and then change all of the components. Yes, I am capable of doing that, but Wow! — what a job that would be. And then there's the cost of new circuit boards! I didn't have the inclination, nor, for that matter, the finances.

How about the USA?

Finally, I wrote to the organ builders in the USA, from whom I had purchased the service manual way back in 1977. I couldn't immediately find them, as they had moved house and the letter came back 'not deliverable'. It was time to use the 'overseas telephone' and here I struck oil.

The whole bank of boards (complete, tested and ready to go), was replaced for just A$505, including air freight from the USA. Baldwin also supplied free of cost a new set of plastic socket holders, which I hadn't realised were splitting with age.

It took around eight hours to remove and replace the sockets, but that proved to be the most time consuming part of the exercise. I'm pleased to say all worked as new straight off. It had taken six months to locate the parts and have them delivered to Aussie, but it was worth the wait.

The rest of the organ is weathering the salt-laden air pretty well. Frequent use of contact cleaner is a must, and I sprayed several coats of circuit board lacquer on the new boards before installing. They should last the life of the organ. I did consider inverting the whole bank, but it would be a mammoth task as the wiring harness is much too short.

Over the years I have successfully repaired a number of faults, with open circuit signal diodes being the main problem. Only one capacitor has ever failed, a 0.1uF in a tone generator. With the excellent service manual, faults are relatively easy to repair.

This organ was originally designed

about 1972 and was current until about 1987. Of course, there were modifications over the years but still, that's not a bad life for a single model. Mine was manufactured in 1975-6.

Thanks, Arthur. That was quite an interesting story, and it carries an important lesson for anyone charged with servicing equipment that has spent any length of time in a salty environment.

These days, most well made equipment is 'tropicalised' at the time of manufacture. Boards are usually varnished automatically as they come off the assembly line. But there are times when a board misses the spray, or the 'bean counters' at head office decide that saving the cost of a coat of varnish will improve their profit margin. So it pays to be observant.

As a matter of interest, a knowledge of local meteorology can be a great help in anticipating the kind of troubles one might find. I have found that any set which comes from a seaside address where the winds are consistently on-shore will inevitably contain corrosion such as Arthur has described in his story.

TV sets from popular surfing beach areas are a well known example of this kind of corrosion problem. On the other hand, salt spray causes very little trouble in seaside areas where the local wind is off-shore. So a TV from a 'calm water' beach resort is unlikely to give much trouble with corrosion.

Young, but keen

Our next story might have been passed over if it had come from an experienced serviceman. Instead, it is printed here to record what might be termed the hope for the future of electronic servicing.

The story comes from Myles Eftos, of Carine in WA. Myles is one of a diminishing band of young people with an interest in repairing electronic equipment. There are still plenty of youngsters around with an interest in electronics as a general subject, but there are precious few who care about fault finding and repairs.

Here is Myles' story...

I am a 14 year old budding electronics enthusiast and I recently completed my first proper repair.

My Dad has a Sherwood amplifier (S-9400) and the sound had become very distorted. He took the amp to a professional serviceman, who said that without a circuit diagram he couldn't repair it.

Now, my Dad was about to ditch the amp so I asked if I could have a look at it and he agreed. The first test I did was aimed at eliminating some possible causes of the fault.

Since this model has an 'effects loop' I could connect a test signal straight through to the power amplifier. The sound came through loud and clear. "Aha! The preamp!" I thought. So I took off the cover and had a look.

My next problem was finding the preamp board and since I didn't have a circuit it wasn't easy. I narrowed the possibilities down to two boards. I checked all the transistors on both (there were only a handful), but they were all OK.

So I left the problem for a while and then it struck me: "The power supply!" (Actually an idea struck me, not the power supply!) I still have no idea why I thought of it, but I followed up the hunch and discovered the B+ rail to the preamp was low — around 3V.

Even without a diagram I could safely say 3V is pretty low for a preamp. Just to be sure, I checked a few other boards and the rails there were at around 40V.

I traced the fault back to an output transistor on the power supply board and it was leaky. Very leaky, because when I replaced it, the preamp rail was back up around 40V.

So that is the story of my first proper repair job. I was happy, because I scored some money, and Dad was happy because he got his amp back. Although it was a fairly simple repair, I'm pretty proud of it and I certainly hope it won't be my last.

So how about that? I'll wager there aren't many of us who can remember their first ever serious job. I know my first one is lost far back in the mists of time. So Myles has not only remembered his first job, but has also scored a second payment by having it recorded in these pages.

The story has an important lesson for Myles (and a reminder for the rest of us). The first commandment of servicing says "Thou shalt first check voltages!" Ninety percent of failures result in wrong voltages, and a voltage check usually points you in the right direction, right at the start of the job.

Good work, Myles, and I hope we will hear a lot more from you in the future. Just one thing though. Don't be too hard on the 'professional' serviceman who knocked back the job. Just finding your way around in unfamiliar equipment can be very time consuming, so a circuit diagram is essential to keep the cost of the job down to an economical level.

Incidentally, going back to my comments at the beginning of Myles' story, there are very few new service techs coming out of our TAFE colleges. There are any number of skilled technicians, each one a full bottle on theory and how things are put together. On the other hand, there are very few who can make sense of the question "What if...?".

A skilled service tech has to look at the symptoms, then wonder what kind of component failure would cause those symptoms. A good service tech needs a vast and vivid imagination, plus a strong tendency to think laterally.

A lot of our older servicemen have got that way out of habit and long experience. It's almost impossible to 'teach' the art to younger people. That's why young Myles Eftos deserves all the encouragement he can get.

Honesty pays...

The next item is more of an observation than a service story proper. It's surprising the number of customers who will go to no end of trouble to cover the fact that they were in some way responsible for the failure of their appliance.

I imagine that every housewife knows that she shouldn't put flowers on the TV. Yet even when the set comes in with leaves and flower petals washed in through the ventilation slots, she will deny ever having blooms anywhere near the set and will blame the kids, the cat, and even her husband. But it is never her fault. Well, mostly never her fault.

These musings were prompted by an experience at a friend's workshop just a day or so ago. It probably wasn't flowers this time but still, the owner denies any knowledge of a possible cause of the trouble. The result of this spill was clearly evident, but it could have been otherwise and a bit of honesty by the owner might have saved a lot of time and hassle for the serviceman.

The set in question was a Samsung

48cm model and the complaint was that it had gone dead. When it arrived on my colleague's bench, the first thing he noticed was a patch of rusty brown stain on the cabinet back. With the back removed, a visual inspection revealed a similar deposit on the PCB, immediately under the stain on the cabinet.

Whatever the material was, it had hit the edge of the board and run in among the components around the horizontal and vertical oscillator chip. The chip was one of those 48-pin 'does everything' types and he wasn't going to remove that until he had tried everything else.

Surrounding the chip were several greencaps, a few resistors and one of those micro-miniature trimpots now so common in electronic equipment. Each of these components was liberally dosed with a brownish powder — obviously the residue left after the liquid contaminant had dried out...

With these components out of the board and cleaned of the powdery residue, my colleague found that the capacitors had gone low in value, and were temperature sensitive into the bargain. The fixed resistors didn't seem to have suffered too much, but the little trimpot was a write-off. One of its three legs was missing and the other two were suffering from severe corrosion.

After thoroughly cleaning the board and replacing the faulty components, the set was restored to perfect order. We have no idea what the corrosive material was, but it looked and smelled for all the world like the gunk from a rotting dry cell. We can't imagine how such a material could be dripped into the back of a TV, accidentally or otherwise. But we're sure that the owner knows, and could tell us if he wasn't so afraid of revealing his lack of commonsense.

As I mentioned above, in this case the contamination was plainly obvious; but it is not always so. Many times the liquid does its villainy then dries up, leaving no residue to give a clue to what or where the trouble might be. An honest, even if embarrassing statement from the owner can often prevent hours of frustration for the unfortunate technician charged with doing the repair.

Tips for contribs

We are still getting a steady stream of contributions from readers, for which I am very grateful. Please keep up the good work. However, a few notes about submitting your contributions may not go astray.

If at all possible, please type your story, using a new ribbon. Now that we can use electronic scanning to get the stories into the computer, double spacing is not so important. However, typing on only one side of the paper is probably more so, as this avoids having the scanner try to read the reversed material on the other side of the paper!

Of course, the ideal way to submit a story is on a floppy disc from a word processor. This way, we don't have to retype or scan it at all! We can accept all common floppy formats, but if you only have access to an unusual type of computer or an offbeat word processor, best contact us first to see if we can read that format.

If you don't have access to either a typewriter or word processor, we will still be pleased to accept your handwritten contribution. Please write clearly in ink, double spaced and single sided.

In the case of handwritten material, it's a good idea to ask a friend to read through your manuscript and point out any words he has difficulty with. If he has trouble with your handwriting, there's a good chance that I will too. And it's better to correct that problem before you send in the story.

Finally, remember that a monthly magazine has a long lead time. I like to keep three or four months ahead of the Editor, and he and the printer take a couple of months to do their part of the job. So it could be six months or longer before your story appears in print.

All contributions are acknowledged by the front office. This should take only a few days. Then they are passed to me for consideration and all those that I can use are entered into my word processor.

If I can't use an item, I'll write back explaining why it can't be used and inviting you to try again. This should arrive within a couple of weeks. So if you don't hear from us within a month of the first acknowledgement, then your story is most likely going to be used, sometime in the next six to 12 months.

If you are writing about commercial or industrial subjects, then copies of the relevant circuits or drawings would be appreciated. We have access to circuit diagrams for many domestic type appliances, but a copy of the relevant part of the circuit with your submission is often convenient.

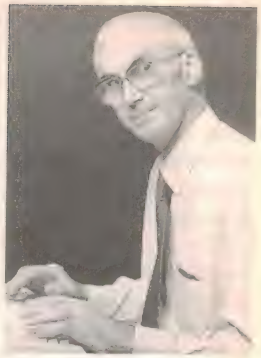
So go for it. We have plenty of room for new stories, so make sure that yours is among them. And you'll be paid for it, too!

That's all for this month. See you again next time? ❖

An overall view of the Baldwin Cinema 2 organ, again taken from the service manual. Made in 1976, it is very solidly built and after having the Fantom Fingers section replaced is now operating 'as new'.

FORUM

Conducted by Jim Rowe



More about the possible health risks from electromagnetic fields

There's been a positive, though not exactly overwhelming response to our discussion in the October column, about the possible health risks from E-M fields. I find this modest response a little surprising, because of the way we're all likely to be affected to some extent — not just those who spend considerable periods each day with a small digital transceiver held in close proximity to their cranium...

Just before we start, though, I'd like to offer my apologies for the non-appearance of Forum last month. As I explained briefly in the leader, I had a health problem during that issue's production cycle and as a result there just wasn't time to prepare Forum along with everything else. Still, it *was* the first time I'd had to leave it out after taking the column over from Neville Williams nine years ago, so I must confess to feeling only a tiny bit guilty!

In any case, the short break has given more time for people to respond to the matters raised in the October column, about possible health risks associated with electromagnetic (E-M) fields. And there has certainly been a response, as you'll see, although mainly from the same people who have contributed to this topic previously. To be honest I still get the feeling that by and large, many Australians are a bit apathetic about public health and safety issues — even those like this one, that could have the potential to affect just about all of us.

Anyway, let's turn to our first response, which comes from Dallas Filby, of Wodonga in Victoria. Here's what Dallas has to say:

I have been following the E-M debate with much interest since about 1993 and in particular, I've been keeping a careful eye on any reports involving mobile phones and RF radiation.

About two years ago, I remember seeing a news item on TV regarding a scientist from the Victorian town of Ballarat who had just invented a shielding process that would protect mobile phone users from the effects of RF radiation. I don't have an electronics background but from memory, the process went something like this. The inventor apparently placed an array of directional antennas against the main antenna positioned directly opposite to the head of the user. This had the effect of shielding the user while actually boosting the signal from the mobile phone by about 50%. The cost of implementing this would be minimal, he said.

I immediately thought that his idea would be snapped up by Telstra and Optus, and in about 12 months time I would be able to purchase a shielded mobile phone. So, 12 months later I went into my local mobile phone shop and asked to see their range of phones that used shielded antenna technology. The manager looked at me as if I had big ears and came from the planet Vulcan. I may as well have been asking for a Warp drive for my Volkswagen.

Apparently, this invention would not take the interest of the mobile phone marketing departments because their philosophy is, "anything that increases the price — even by a small amount — isn't worth considering".

I believe that there must be many people like myself who would be prepared to pay more for mobile phones that had lower levels of RF. Have you heard of this invention, or know if their are any brands of mobile phones available that offer some level of RF protection?

Also, you mentioned at the end of your Forum article that you "couldn't understand how the standards people seemed to be prepared to dismiss the warning signs now fairly apparent in the scientific literature". Perhaps it can be explained like this.

Physicist Marie Curie wouldn't accept that uncontrolled doses of radiation were harmful, or that the years of illness that she suffered were caused by or even related to the radiation delivered by the hundreds of kilograms of Uranium ore that she processed by hand over her lifetime in order to isolate Radium, one of her most noted discoveries.

It was only long after her death and the deaths of many other people who came into contact with radioisotopes — such as the watch face painters who used Radium-based paints to place fluorescent markers on to watches and aircraft instruments — that the community started to consider that they had been misinformed about the health effects of Radium and radiation.

Like Marie Curie, perhaps our grandchildren will eventually refer to the early development of cellular phones in the same way.

Thanks for those comments, Dallas, and you may well be right about the possibility that our grandchildren will view current attitudes towards cellular phones in much the same way as we regard previous attitudes towards radium. Hindsight is always much clearer than foresight, isn't it? Vested interests don't help, either. I'm reminded of an old saying my grandmother was fond of: "There's none so blind as those who simply don't wish to see..."

By the way, I hadn't heard about the reflector-type cellular radio antenna to which Dallas refers, invented in Ballarat about two years ago. I'm aware about the one announced earlier this year in the UK, though, and another developed at Griffith University in Queensland. More about the latter shortly.

(Before I forget, a few readers have asked if we have contact details for Microshield Industries, the firm mentioned in the October column. Their address is given in *New Scientist* as Microshield Industries PLC, UK House, 24 Ribocon Way, Luton, Bedfordshire UK.)

Some background

Moving on, our next contributor is Rex Newsome VK4LR, who is apparently a lecturer at the University of Queensland. Rex confirms that the Dr Ross Adey referred to in the October column is originally an Australian, who grew up in Adelaide. He advises that Dr Adey was in fact project director for Bonny, the 'ape in space' project. Now well into his 70's, he is also a radio amateur with the callsign K6UI and is often heard on the 10m and 20m bands talking to his friends in Australia.

Rex Newsome also sent in some material extracted from a book he has written himself and uses in teaching, called *Introduction to Human Factors* (1996). It provides some very relevant comments on our present topic:

Electromagnetic radiation

There has been recent concern that radiation emanating from the electronics and other electrical devices may be hazardous to health. One outcome of this concern is a plethora of reports, and conference papers, and many books on the topic (for example, Becker & Seldon, 1982; Smith & Best, 1989; Dalton, 1991). Electromagnetic radiation (EMR) is energy propagated as a wave-type phenomenon through the static electric and magnetic field in which the universe is bathed.

Two principal parameters of EMR are frequency and intensity. EMR can span an enormous range of frequencies. This includes the spectrum that we know as light. At the extreme high frequency end gamma rays, X rays, and the upper end of the ultraviolet band form what is known as ionising radiation. At much lower frequencies EMR becomes so useful for communications that this part of the spectrum is virtually jam-packed with radiation from many million sources. Intensities range from a few milli-gauss, such as may be expected from a computer screen at reading distance, to fields of more than 1000 gauss as can be found in industrial settings. Unease starts when one considers that, before about a century ago, much of this spectrum was totally silent. The only exception was the weak modulation of the earth's magnetic field from solar activity and transitory pulses created by lightning.

In contrast, presently every organism on earth is subject to human-made radiation. There are many possible sources, including power lines, personal computers, AM and FM radio stations, TV transmitters, communication satellites, magnetic anti-theft devices in shops and libraries, airport and seacraft microwave radar, home appliances, a variety of industrial machinery, and even digital watches.

As Becker and Seldon (1982) point out, our electromagnetic background has changed more than any other aspect of our environment. The density of EMR energy around us can be 100 to 200 million times that of our ancestors a century ago. Many writers have suggested that biological organisms evolved in what was essentially a quiescent EMR environment may not be able to cope well with high EMR levels. The health concern is especially for work situations where EMR fields can be many more times as intense as what we now accept as normal.

It is beyond the scope here to review research into EMR effects on health. However, while much of the evidence that is on offer is equivocal as interpretations depend on complex epidemiological arguments, there is sufficient of veracity to suggest that high EMR situations should be treated with caution. Nonetheless, there are some authors (For instance, Foster, 1989, Repacholi, 1990) who are less pessimistic.

There is evidence to suggest that

EMRs of frequencies below 50Hz, or higher frequency ones modulated by low frequencies in that order, because of the closeness of these to micro-biological rhythms, can be particularly stressful to biological organisms, humans included. EMRs modulated by low frequencies are used in some industrial processes and exposure of workers near such processes should be monitored.

One particular source of high radiation dosage now very prevalent is the VHF handheld walkie-talkie or telephone. While these devices are intrinsically not sources of high power EMR, the use of these puts the antenna within a few centimetres of the user's brain. Under such circumstances the field strength applied to the temple area can be at least an order greater than the maximum levels set by a number of governments. Where possible handhelds, if they must be used, should be of a type that locates the antenna as far as possible from the temple of the user. Only the minimum power sufficient for the job should be selected.

Predominant in the EMR debate has been the issue of the video display terminal (VDT). VDTs, and similarly the screens used by most personal computers, use pulsating magnetic fields to direct the electron beam as it writes. The VDT is therefore a source of EMR, both of the ionising type that is, gamma rays and X rays, and the non-ionising type. While the matter of VDTs as a health hazard is taken up in Chapter 12, it seems that VDTs (and personal computer screens) are not a major problem.

Thank you for sending that information on Dr Adey, Rex, and also for that extract from your own book. It seems a balanced summary of the overall situation, if perhaps a bit brief.

By the way, I'm including some of books you refer to in a list of references, later in this column.

More background

Moving on again, our next response comes from one of the people who contributed to the October column: dentist Dr Tony O'Brien of Charlestown in NSW. Dr O'Brien provides interesting further background information on some of the researchers who are active in promoting public awareness of the possible risks of EMR:

Thank you for running my letter on EMR and for your even-handed treatment of the matter. I am sure that time will show that you have rendered a public service of some magnitude.

I did write to another magazine following an article on the subject in their June issue, but so far I have had no response from them.

Some background information which may be of interest...

Ross Adey is an ex Australian... another promising student enticed overseas in his youth. He has done some good work on the subject of EMR effects at the cellular level, and is the author of the wonderful phrase: "the cells whisper to each other with faint chemical and electrical messages".

Robert Becker is a retired orthopedic surgeon who chose to spend his working life in the Veteran's Administration Hospital service, which gave him the opportunity to carry out some fascinating work on the electrical system of the body — his books you will find hard to put down. His work was limited only by the difficulty in obtaining research grants. Becker thinks that paraplegia will respond to combined surgical and electrical treatment of the severed spinal cord. It is only a matter of getting enough money to carry out the necessary experimental work. He also thinks that engineers should be looking at the feasability of increasing the supply frequency up to the region of 400Hz, as 50/60Hz is too close to the brain wave frequencies.

Nancy Wertheimer returned to science after bringing up her family. She was interested in the apparent clustering of childhood leukemia in parts of Denver, and with the help of a physicist friend named Ed Leeper finally traced the problem to the street wiring configuration. She was loath to publish the work in the hope that she was wrong. At the moment she is interested in 'hot plumbing', which appears to be a problem in parts of the US.

To explain: if a neighbour's neutral return is faulty, the current may flow via the plumbing to your neutral and cause an imbalance in your supply — which can lead to massive magnetic fields in and near your house. One cure is to place a plastic section in the supply pipe to your house... This of course can be hazardous to the plumber, and must be done under the supervision of an electrician.

A friend of mine has been in touch with Nancy Wertheimer recently and she has promised to send him some material which I will send to you as soon as I get it.

Sadly, many scientists in the US are afraid to speak up on the matter because of perceived threats to research grants. They also have the problem of massive over-the-horizon radars and ELF transmissions in and near populated areas. We are fortunate to have the CSIRO and people of the calibre of Stan Barnett and his colleagues.

This whole matter is, I think, ready to explode and will make the asbestos drama look like a hiccup. Paul Brodeur, an investigative journalist and author of a number of books, thinks that there has been a massive cover-up in the US.

Thanks for the additional comments and background information, Dr O'Brien. Thanks also for sending a copy of the recent paper by Nancy Wertheimer and her colleagues, about ground currents and the attendant risk of childhood cancer. I'll try to read and digest this shortly, and include comment in a later column.

Impressive abstract list

Incidentally, Dr O'Brien also very kindly loaned me the latest copy of *BENER: Biological Effects of Nonionising Electromagnetic Radiation Digest Update*, a quarterly publication from Information Ventures Inc. of 1500 Locust Street, Suite 1513, Philadelphia PA 19102-4314 USA. Published in A4 format, it's essentially a listing of new items, current literature and meeting abstracts relevant to this topic. And the fact that this one edition of BENER runs to no less than 144 pages surely emphasises that there are a great many scientists around the world who regard the topic as important!

I was interested to see, right at the start, two relevant news items that as yet haven't received much coverage in the media here — even though they both originate in Australia. I hope the publisher won't mind me drawing them to your attention:

AUSTRALIAN RESEARCHER FINDS LINK BETWEEN TV TOWERS & CHILDHOOD LEUKEMIA:

An Australian physician has completed a long-term study on the link between residential proximity to television towers and the incidence of childhood leukemia. Dr Bruce Hocking found that the rate of childhood leukemia was 60% higher in those living near three television towers in Sydney, compared with those living farther away. Moreover, deaths from childhood leukemia were 120% higher

Suggested References

For those who would like to look further into the question of possible health risks from E-M fields, here is a list of references that have been recommended by other readers:

Becker, R.O., & Seldon, G., *The Body Electric: Electromagnetism and the Foundation of Life (1985). Morrow, New York.*

Dalton, L., *Radiation Exposure* (1991). Scribe, Newham.

Horton & Goldberg, *Power Frequency Magnetic Fields and Public Health*, 1995. Published by CRC.

Milham, S., 'Mortality from leukemia in workers exposed to electrical and magnetic fields', *New England Journal of Medicine*, 307, 249, 1982.

Milham, S., (1985) 'Silent keys: leukemia mortality in amateur radio operators', *Lancet*, 6 April 1985, 812.

Repacholi, M.H., 'Cancer from exposure to 50/60Hz electric and magnetic fields — A major scientific debate', *Australasian Physical and Engineering Sciences in Medicine*, 13(1), 4-17, 1990.

Smith, C.S., and Best, S., *Electromagnetic Man: Health and Hazard in the Electrical Environment*, 1987. Dent, London.

in the nearby residents than in residents living at a greater distance.

Dr Hocking, president of the Australasian Faculty of Occupational Medicine and former chief medical officer at Telstra, the Australian state-run phone company, announced the results on 10 May 1996 at the annual scientific meeting of the Royal Australasian College of Physicians in Canberra.

The study, which examined cancer incidence and mortality between 1972 and 1990, compared six regions in the area of northern Sydney, three of which were near to the television towers and three of which were more distant. Although the research revealed differences in the rates of leukemia between different areas, it found no difference in brain tumour rates.

The reported risk increases are generally similar in magnitude to results of other studies examining the relationship between residential power-frequency EMF exposure and incidence of childhood cancer. A 60% increase in leukemia rates translates to a relative risk of 1.6. Past studies on overhead power line EMF exposure have found relative risks of approximately 2.0.

Dr Hocking presented preliminary results in a poster session at the annual Department of Energy Contractors' meeting in November 1995, but his poster submission was too late for inclusion in the abstract publication.

News of this research was previously reported in the November/December 1995 issue of Microwave News. According to this source, Hocking's team measured a radio frequency/microwave radiation power density of 8uW/cm² (microwatts per square centimetre) in the areas close to the antennas and power densities of 0.2uW/cm² at a distance of 2.5 miles from the antennas. Meanwhile, in control communities 7.5 miles from the antenna, the power densities were approximately 0.02uW/cm².

All measurements were well below Australia's standard for radio frequency radiation, which sets limits of exposure at 200uW/cm² for radiation of frequencies from 30MHz to 300GHz. 1992 standards standards set by The American National Standards Institute and the Institute of Electrical and Electronics Engineers set exposure limits of 200-600uW/cm².

Dr Hocking called on the Australian federal Communications Department to fund other research in this area to confirm his conclusions. He said that it was too early to decide whether governments should ban the building of communications towers, including mobile phone relay stations. However, he added, his research might affect people's thinking about the erection of such towers in residential areas. (Australian Associated Press, 10 May 1996)

AUSTRALIAN GROUP DEVELOPS EMF DEFLECTING MOBILE PHONE ANTENNA:

Australian engineers have developed a mobile phone antenna that they claim will reduce radiation exposure to 1/1000th of current levels. Professor David Thiel and his colleagues from Griffith University in Queensland have spoken to potential manufacturers and expect the device to be on the market in three to six months. "They'll be a simple drop-in device", said Thiel.

In addition to reducing exposure by 'steering away' radio waves from the user's head, the replacement antenna is intended to increase the phone's battery capacity by more than 70% and increase the phone's range by more than 50%.

The group began research four years ago after a technician in the United states sued his employer, claiming that his on-the-job cell phone use caused his

brain cancer. "With more than 30 million mobile phone users worldwide the invention has the capacity to earn valuable export dollars," said Thiel.

The announcement came on the heels of a British group's launch of a cell phone protective device earlier the same week. (Australian Associated Press, 18 April 1996.)

As you can see, both items are very relevant to our present discussion, and of such importance for public health that I'm surprised they didn't get more coverage in the popular media. On the other hand perhaps it isn't all that surprising, as the first story directly involves virtually all of Sydney's TV stations, and the second story is presumably of indirect concern to Telstra and Optus, who are major advertisers in the media...

Anyway, my thanks again to Dr O'Brien for loaning me the BENER Digest. For those who'd like to obtain more information on this publication, Information Ventures can be contacted via email at **EMF-Link@infoventures.com**, and is also on the World Wide Web at **http://infoventures.com**.

Ms Venables replies

You may recall that the thing that largely triggered our discussion of E-M fields and their possible health risks in this column was a letter by Ms Betty Venables in our June issue, commenting on an supporting my leader on the subject back in the September 1995 issue. Her letter in turn produced a critical response from a David Samuels of the Australian Radiation Laboratory, and then it all started in earnest...

Well, Ms Venables has now taken the opportunity to reply to Mr Samuels. Here's what she has to say:

The ARL's Mr David Samuels postulates that you and I should not comment on EMF exposure and health, due to our lack of a sound knowledge of epidemiology and a conservative approach. Seven years of study of the scientific literature dealing with 50-60Hz and microwave-/radio frequency radiation, prompted by a consulting physician, I believe gives me the right to comment. Regular contact with thinking members of the community, medical and scientific professions as well as people in industry who share our concerns, increases the resolve to persue this issue.

As to the conservative approach, I went beyond this about five years ago, sharing the opinion of a scientist who stated that all the questions had been answered.

Certainly anecdotal evidence is not 'scientific'. It does, though, provide information upon which further scientific study can build, which in turn provides the information on which Standards and other guidelines are based. Therefore anecdotal evidence is of immense importance, and to dismiss it is, if nothing else, to invalidate human experience. To ignore it when it is obvious that further study is required is less than honest, and amounts to a dereliction of 'duty of care' by those responsible.

As for epidemiological studies, when I asked why these were not being conducted in this country, at a recent meeting of the Electromagnetic Energy Committee (EME) convened by the Federal Government, it was said that epidemiological studies could not provide the answers. An alternative was not suggested.

Mr Samuels is correct, however, in that we contributed little to the scientific debate. It would appear that anyone who advises caution in regard to EMF/RFR exposure, and could contribute to the debate, are excluded by the very system in which they operate. Their recommendations may influence changes that would obviously be unpopular, in our commercially oriented society.

We acknowledge that the EMF/RFR health issue is one of monumental proportions. It will not, however, go away and must be faced and dealt with, despite the cost.

The Standards of exposure to EMF/RFR to which industry must comply are determined by study of selective scientific reports, as evidenced by the reference list attached to the Standards, and many 'fact sheets' issued by authorities. Industry complies with those all-important Standards, and feels justified in their decisions. Therefore the EMF/RFR emission levels of a product or service are legitimately determined at that point, which then becomes acceptable to all those who are less informed.

As a rule the conclusions of most studies offer very conservative opinions. Often, though, the private opinions of people dealing with this matter are far less conservative.

The CSIRO Report compiled by Stan Barnett, and those compiled by Don Maisch are important documents, contributing immensely to public awareness and education. As does your publication, by reflecting open mindedness on this issue.

Thanks for those comments, Ms Venables. That comment that epidemiological studies 'would not provide the answers' was quite an eye-opener, wasn't it? Presumably epidemiology only serves to freeze out riffraff like ourselves, in the view of the person concerned.

More local reports...

We've almost run out of space again, but before I close I must note that I've received some further material on this topic from Don Maisch, of EMFacts Information Service in Hobart. You may recall that I mentioned Don in the October column, and quoted an excerpt from one of his reports. It's clear that he has been gathering information on this topic for quite a while, and has helped provide research material for people like Australian Democrats Senator Robert Bell, to help raise public awareness.

Anyway, Mr Maisch has obviously been busy again, judging from the material he's sent me. One is a short report entitled *Electromagnetic Energy (EME) as a Risk Factor to consider in the Treatment of (1) Childhood Cancer and (2) Breast Cancer*. It's again intended to raise awareness about growing concerns regarding the possibility that cancer could be triggered or promoted by E-M fields — including those used for cancer investigation or treatment — it should interest many people.

Another report is basically a critical commentary on an information sheet issued by the South Australian Health Commission, entitled *Radiofrequency Fields: Is There a Health Hazard?*. Mr Maisch's report quotes evidence which is somewhat at odds with some of the statements in the SAHC sheet, and gives a useful list of references.

Mr Maisch also sent me an abstract of his report *Mobile Phones and their Transmitter Base Stations: The Evidence for Health Hazards*, the existence of which was mentioned in the October column. From the abstract, it seems to be a particularly informative and worthwhile report. There's no room to quote from it here, but I'll try to do so next month.

In the meantime, the full report (over 200 pages) is available for $35 plus $8 express postage from Mr Maisch at EMFacts Information Service, PO Box 96, North Hobart 7002; phone (002) 430 195, fax (002) 430 340 or email on **maisch@ice.net.au**. The other small reports are also available from him, although their prices weren't marked.

I'll try to include some more material on this important topic next time. I hope you'll join us. In the meantime, have an healthy and enjoyable Christmas and New Year season. ❖

NEW BOOKS

Video reference

VIDEO ENGINEERING, 2nd edition, by Andrew F. Inglis and Arch C. Luther. Published by McGraw-Hill, 1996. Hard covers, 236 x 156mm, 518 pages. ISBN 0-07-031791-7. RRP $160.

An expanded and updated second edition to this book, intended as a reference for both video professionals and students of video engineering, in its many current forms.

It now covers digital video and HDTV, compression systems, computer video and interactive multimedia video, digital video editing, satellite TV receivers, CATV and cable delivery of Pay-TV, and fibre-optic transmission. This is in addition to a lot of basic theory on conventional analog video, covering image scanning principles, colour video, image quality, application of colormetric theory to video systems, video encoding systems, video cameras, professional and consumer-level video recorders, and terrestrial TV broadcasting. In short, it is indeed comprehensive.

At the same time, it's concise but thorough. Both authors have worked for many years in the professional video area (with RCA in the USA), and their combined knowledge and experience has produced a sound and satisfying basic reference work. They also seem to have kept their knowledge reasonably up to date, judging from the material on fairly recent developments like digital compression, computer video systems and so on. There's even a chapter at the rear discussing expected future trends in video technology.

For anyone seeking a good solid reference on this important subject, it can be recommended. The review copy came from McGraw-Hill Australia, of PO Box 239, Roseville 2069. (J.R.)

Basic electronics

UNDERSTAND ELECTRONICS, by Owen Bishop. Published by Butterworth Heinemann, 1995. Soft covers, 153 x 233mm, 296 pages. ISBN 0-7506-2100-1. RRP $35.95.

Claimed to be for anyone who wants to know about electronics, this book begins with an outline of electricity and the laws that govern its behaviour in a circuit. Topics include the electric field, charge, voltage, current, batteries and so on. Resistance is given its own chapter and includes some of the basic equations like Ohm's law, series and parallel resistance. Capacitance and inductance are also allocated a chapter each, with AC theory appearing in both chapters, rather than being explained separately.

Simple RLC circuits are covered next, although most of this chapter is about resistive circuits, with resonance given a page or so. Solid state devices occupy two chapters, which cover semiconductor theory, transistors, diodes, FETs and so on. A chapter on simple circuits follows, and then the SCR, triac and other thyristors are explained (although only briefly), followed by transducers, sensors, light sources and displays.

The rest of the book describes oscillator and amplifiers, test equipment, op-amps, digital logic, audio, computers, telecommunications, microwaves, medical and industrial electronics.

There is very little maths, and lots of diagrams. But the treatment of all topics is necessarily brief, given the small size of the book and the large number of topics covered. The writing style is free of jargon and easy to read.

The review copy came from Butterworth Heinemann, of PO Box 146, Port Melbourne 3207. (P.P.)

Satellite TV

THE WORLD OF SATELLITE TV, Australia/New Zealand Edition, by Mark Long. Published by MLE Inc, 1996. Soft covers, 248 x 187mm, 216 pages. ISBN 0-929548-16-7. RRP $29.90.

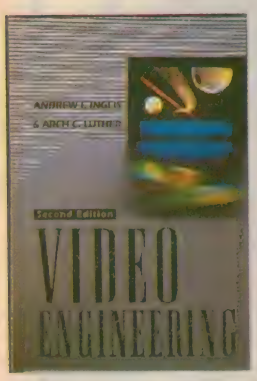
The latest edition of Mark Long's extremely popular book on domestic satellite TV, tailored specifically for the Australian and New Zealand area. Melbourne businessman Peter Lacey has been involved in its preparation, and unlike previous editions it has been printed in Australia.

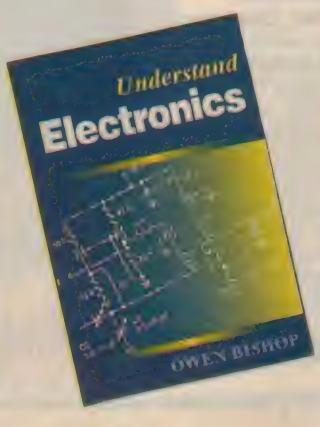
As with Mark Long's other books and articles, it provides a lot of solid practical information — both on the basic principles and on the 'nitty gritty' of satellite reception. There are chapters on satellites, receiving antenna systems and components, feedhorns, LNBs and polarisers, receivers, encryption and decoders, the practicalities of installing a system, troubleshooting and so on. Plus, of course, data on the various satellites that can be received in this area.

As well as leaving out a great deal of the 'global scene' information that's not really of much relevance here, this new edition also incorporates extra material that *does* apply specifically to this area. I noticed, for example, that the chapter on video encryption includes a discussion of B-MAC and E-PAL, which I couldn't find in the 'Asia and Middle East' edition. Similarly the table of typical dish declination and azimuth figures in the system installation chapter has more than double the number of entries for Australian and New Zealand cities.

In short, it's much more relevant to the satellite reception scene in this region than any other book I've seen — which should make it of value to anyone wanting a good reference on the subject.

The review copy came from Peter Lacey Services, of 80 Dandenong Road, Frankston 3199. However I understand that it's likely to be available from Dick Smith Electronics stores as well as selected bookstores. (J.R.) ❖





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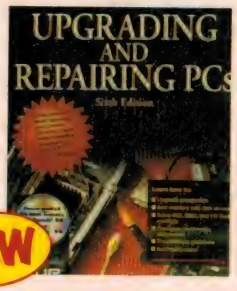

This new edition shifts the focus from IBM PCs to Intel-based systems. Updated to address Windows 95 & Windows NT Version 4.0 issues and concerns as well as recent enhancements including issues on the Internet. Covers all Intel CPU versions. Includes CD with Winstone test.

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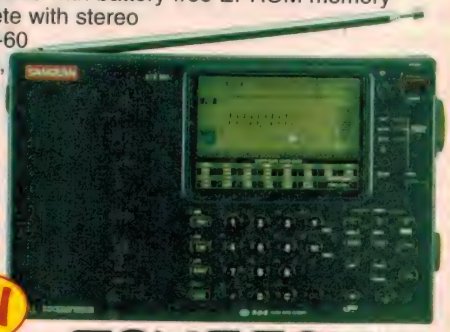

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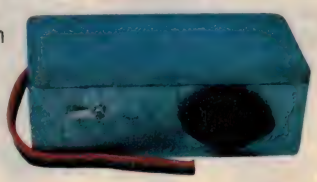

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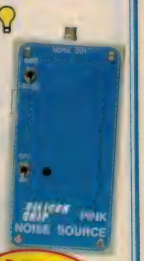

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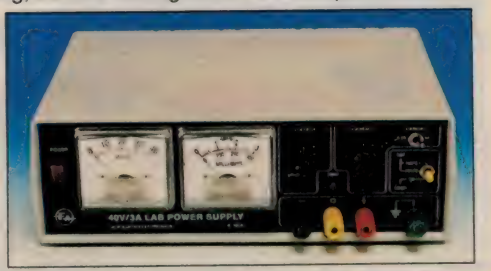

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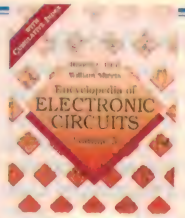

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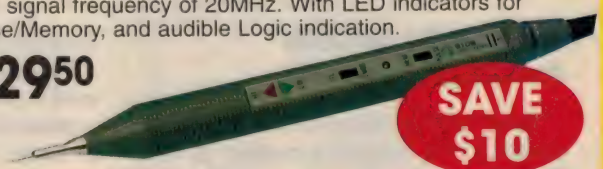

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Reads Pk-Pk & RMS

Electronic FET Analogue Multimeter

Few multimeters can read peak-to-peak voltages and (at this price) even fewer are electronic, yet this multimeter has both. It's overload-protected & has a mirrored 90° scale for really accurate reading.

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- 10M input impedance

Ranges

DCV:	0.3, 1.2, 12, 30, 120, 300, 1200V
ACV:	3, 12, 30, 120, 300, 1200V (plus pk-pk to approx. 1 MHz)
DCA:	0.1uA, 0.3, 3, 30, 300mA, 12A
ACA:	12A
Resistance:	x 1, x10, x100, x10k, x1M ohm
AC Bandwidth:	1MHz
Decibels:	-10dB to + 11dB

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Cat Q-1143 **69.50**

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SAVE $40

Cat Q-1360 **$99**

SAVE $150

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Full Featured 20MHz CRO

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Cat Q-1804 **$749**

B 2657

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Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide any further information.

Frequency counter calibrator uses TV

There will be many cases where the accuracy of a frequency counter or similar instrument will need to be checked easily and often, but where the complexity and cost of *EA*'s TV-Derived Frequency Reference is not justified.

Adjusting the timebase oscillator of a frequency counter requires a precise frequency reference, and the line oscillator of a TV set (when locked into a broadcast signal) can be used since it will be running at a very accurate 15.625kHz.

In most cases it will not even be necessary to make a connection to the TV; a 'sniffer' coil will pick up the signal from the line output transformer or the yoke. This is fed into the counter, which is then adjusted to read 15,625Hz.

This method may or may not be satisfactory depending on the counter's resolution and the accuracy required. It could involve timing how often the least significant digit changes for every tweak of the trimmer; even then it's not known if the meter is reading too high or too low.

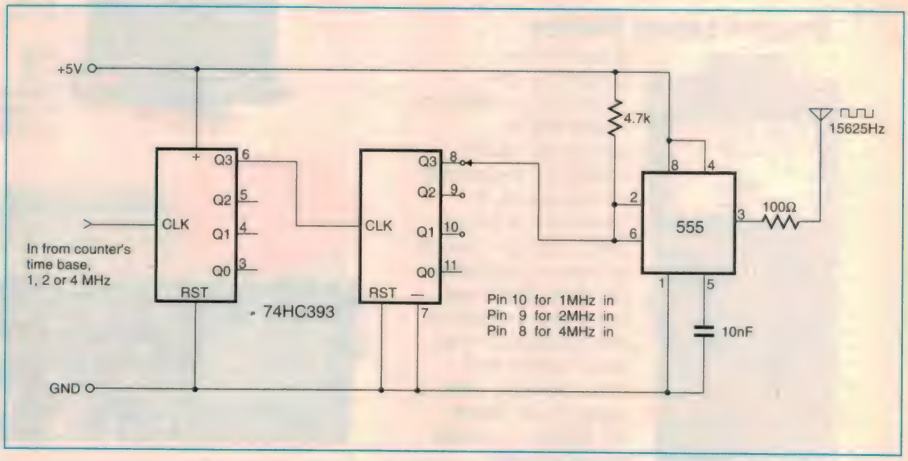
The technique described here is much more convenient and uses the TV itself to display graphically the difference between the two frequencies.

The circuit is best built into, and powered by, the counter itself but it could be a stand-alone unit if desired. It's simply a matter of tapping into the counter's timebase divider chain to obtain a frequency that can be easily divided down to 15,625Hz — for example 1MHz divided by 64. This derived 15,625Hz is squared up to produce harmonics up into the VHF region, where it interferes with TV reception.

The idea is to decouple the TV's antenna to produce a noisy picture that will still lock, and to then couple in the output from the modified counter — the short antenna wire of the calibrator lying nearby is enough. The interference pattern will then contain vertical lines drifting across the screen.

The counter's oscillator is then simply adjusted for minimum drift speed of the lines. If it takes more than seven seconds for a line to return to its starting point on the screen, then the counter is calibrated to within 0.001%.

Graham Leadbeater
Ringwood, Vic. **$45**



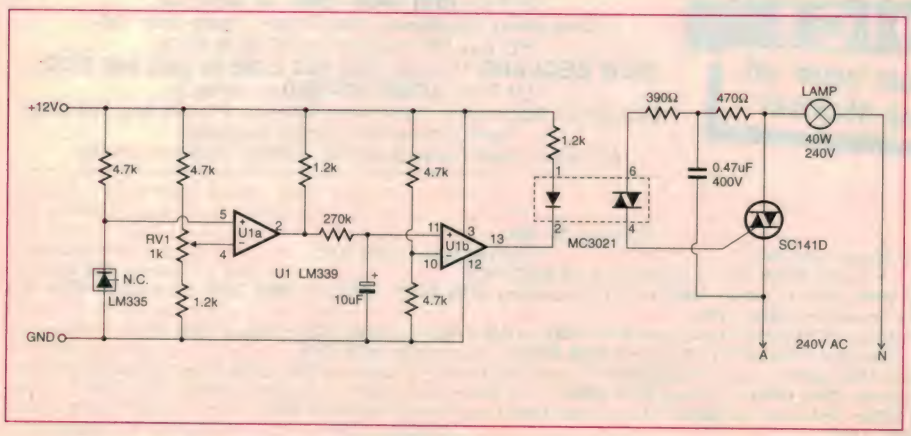
Brewer's temperature control

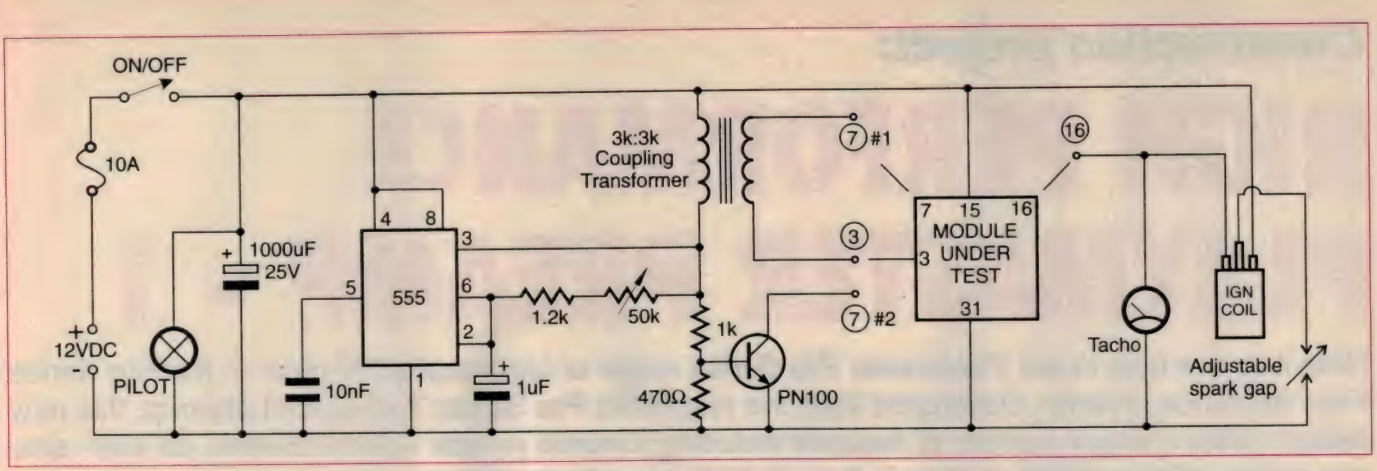
This circuit controls a 40-watt lamp used to keep beer at a constant temperature while brewing. It takes aspects of previously published designs, but perhaps some readers will find it simpler to build and easier to use.

Taking 25°C as the desired temperature, the LM335 temperature sensor will register a nominal 2.98 volts. If RV is set so that the voltage at pin 4 of U1a is 2.98V, U1a's output will go high once the temperature exceeds 25°. This high will charge the 10uF capacitor via the series 270k resistor, and as soon as the capacitor's voltage rises to half the supply voltage, U1b's output will turn off the triac via the MC3021 optocoupler.

When the temperature drops again, U1a turns off but U1b stays on until the 10uF capacitor discharges. This is to prevent the light from flickering on and off as the temperature settles around the desired point. The time constant set by the suggested values of 270k and 10uF seems to work satisfactorily in practice. Different temperatures can be fixed by varying the voltage at pin 4 of IC1a, bearing in mind that the LM339 produces a voltage that changes at the rate of 10mV per degree C.

Greg Fisher
Parkside, SA **$40**





Go/no-go tester for ignition modules

I find that most automotive test equipment is either ultra-sophisticated or ultra-primitive, and a few home grown test units can make life much easier.

One in constant use is a simple ignition module tester which can be used with either the vehicle's coil or the tester's own internal coil, and is portable enough for roadside tests on a go/no-go basis.

The circuit uses a simple 555 oscillator with an output frequency varying from effectively 300rpm on a single cylinder two-stroke to 7000rpm on a V8 engine. A small 3kΩ:3kΩ coupling transformer is used for triggering pick-up-coil driven ignition modules (Mercedes, etc.), most of which will trigger at voltages from 0.3V up. The DC resistance of the transformer's primary is high enough to prevent damage to the 555.

The PN100 transistor is used for Hall effect driven units, most of which trigger on a negative-going pulse.

The tacho is an optional extra, but if used with the vehicle's coil, it can assist with diagnosis. (Tacho reads, no spark, then faulty coil; tacho doesn't read, no spark, then faulty module; tacho reads, coil sparks, then faulty pickup or distributor.)

With a spark module, such as a Bosch 204, the unit can also be used for calibrating tachos and will drive most electronic speedometers for a rough check. My portable unit's test gap is just a spark plug, with the contact broken off for maximum gap. The leads are a standard FM6 connector plugged into the box, with connectors cut off old looms from the wreckers next door and a spare set with crocodile clips.

This is, as mentioned, only a go/no-go tester and as such will not test advance/retard functions. But has proved its worth many times over.

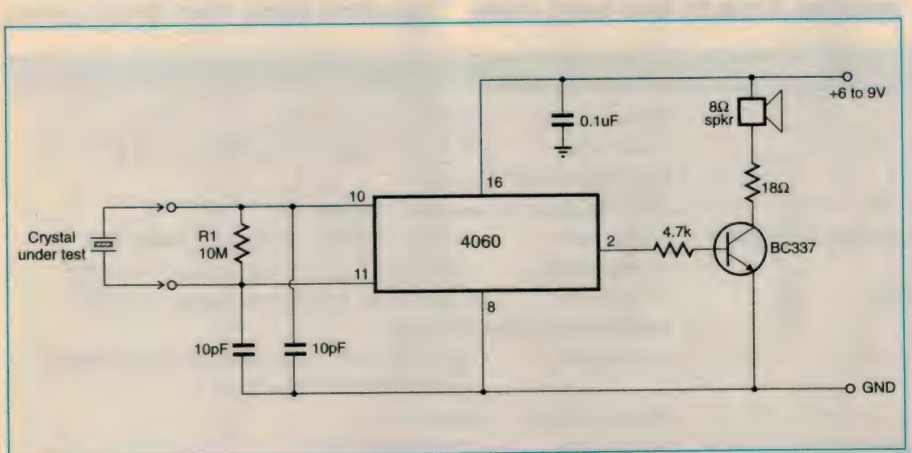
Roy Wallice
Mornington, Vic. **$45**

THIS MONTH'S PRIZEWINNER!

Audible crystal tester

Almost all HF/RF crystals can be easily tested with this circuit, which produces an audio tone if the crystal is working.

IC1 is a 4060 CMOS binary counter, which includes its own internal oscillator circuitry. This oscillator requires only the addition of R1 and the two 10pF capacitors to run at the frequency of the crystal under test. The internal divider chain effectively converts the high oscillator frequency down into the audio range.



The BC337 transistor buffers the counter's Q12 output, enabling it to drive a small speaker. For a more compact unit, a small piezo transducer could be run directly off pin 2 of the 4060.

The prototype performed well with crystals ranging from 1MHz up to 27MHz, the latter producing an audio tone of around 6.6kHz.

Pradeep G,
Alappuzha, S. India. **$25** ❖

WIN OUR 'IDEA OF THE MONTH' PRIZE!

As an added incentive for readers to contribute interesting ideas to this column, the idea we judge most interesting each month now wins its contributor an exciting prize, in addition to the usual fee. The prize is a compact CCD video camera module from sponsor **Allthings Sales & Services**, offering 460 TV lines of horizontal resolution and 0.05 lux sensitivity, and valued at $199.00!

Construction project:

HIGH PERFORMANCE PLAYMASTER PREAMP - 1

Here it is, the next in our Playmaster Pro Series range of high-quality hifi gear — the Pro Series Four reference preamp. Developed from the respected Pro Series Two control preamp, this new design offers a larger number of features including infrared remote volume control, an even simpler construction method, and as before, first-class performance.

by ROB EVANS

While this design has been under development for some time, it became fairly clear during initial stages that there is really no one *fixed* preamp design that will satisfy everyone wishing to build this type of high-quality control unit. In the 'left' faction (so to speak) there are those who prefer a healthy range of features including infrared (IR) remote control, adjustable tone controls, elaborate signal switching and so on; while on the 'right' there are those of a more purist nature who prefer a very spartan circuit arrangement with the *least* possible electronics in the signal path — plus, of course, very high performance from that small amount of circuitry.

Unfortunately in the electronic sense either one of these arrangements tends to preclude the other. For example features such as full remote control over the unit's main functions and the addition of tone controls place a significant amount of circuitry in the main audio path, and therefore must (by definition) degrade the signal quality.

Although these negative effects can often be detected with test instruments, whether on not the average listener can actually *hear* them is a subject for debate in itself, of course. Nevertheless, placing the least possible electronics in the audio path must (again by definition) pass the purest signal to the following power amplifier, and stack the odds in favour of the listener in the audio stakes.

The Pro Series Four

In what we believe is a successful approach to this conflict of interests in preamplifier design, our new control unit includes a range of genuinely useful features such as tone controls, infrared remote volume control, separate headphone amplifiers and extensive input switching. Yet at the same time it allows the user to *bypass* any (or all) active stages that are in series with the audio path, through the use of a front panel 'mode' switch. When all stages are bypassed (in 'direct' mode), the Pro Series Four is effectively a *passive* device and contributes no gain or degrading effects to the signal as it's passed to the power amp.

As you've no doubt gathered, this is really an extension of the idea where a unit's tone controls can be bypassed by a front panel switch, so as to avoid the negative contribution of that circuitry when the controls are not in use. We've just taken this one step further, and given the user the ability to bypass *all* of the preamp's active stages...

Interestingly though, the practical arrangement of a preamp/poweramp combination means that the power amp will actually be driven with a higher impedance source when the direct mode

PRO SERIES FOUR PREAMP — Performance Data

Frequency response
(line inputs, typical load)
Direct mode: Unrestricted
Bypass mode: 15Hz to 30kHz +0/-1dB
Tone mode: 20Hz to 20kHz +/-1dB with controls set to 'flat'

Total harmonic distortion
(20kHz bandwidth, typical load, at 1V RMS output)
Direct mode: Unmeasurable
Bypass mode: Less than 0.002%
Tone mode: Less than 0.002%

Signal to noise ratio
(20kHz bandwidth, unweighted, at 1V RMS output)
Direct mode: Unmeasurable
Bypass mode: -105dB
Tone mode: -100dB or better, depending on tone settings

Channel separation
(1k source termination, 1V RMS reference)
Direct mode: 96dB at 100Hz, 84dB at 1kHz, 70dB at 10kHz
Bypass mode: 92dB at 100Hz, 81dB at 1kHz, 63dB at 10kHz
Tone mode: 92dB at 100Hz, 81dB at 1kHz, 60dB at 10kHz

Input and output levels
(Volume control at maximum, line inputs)
Direct mode: 1V in for 1V out (max output: unrestricted)
Bypass mode: 240mV in for 1V out (max output: 7V RMS)
Tone mode: 240mV in for 1V out (max output: 7V RMS)

Output impedance (approx)
Direct mode: 10k - 100 ohms, depending on Volume setting and input source impedance
Bypass mode: 100 ohms
Tone mode: 100 ohms

Tone controls
Bass +/-12dB at 50Hz,
Treble +/-12dB at 10kHz

Output muting
Turn on delay: Approximately 2 seconds
Turn off delay: Approximately 5 milliseconds

is selected, rather than the optimal low impedance drive that is normally the case. With our circuit, this driving impedance is about 100 ohms in the normal active modes, but anywhere between around 10k and 100 ohms in the direct mode, depending upon the volume control position and source impedance of the actual signal. In theory, this higher impedance will compromise the power amp's noise performance to some degree.

When driving a Pro Series Three power amp with the new preamp however, we were hard pressed to hear or measure this effect coming into play. In the end this could be seen largely as a matter of 'swings and roundabouts', when you compare an un-corrupted high-impedance drive (direct mode) against a high-quality active drive with a low source impedance (normal bypass mode).

It all serves to illustrate the point that the 'ideal' audio path is not quite as simple as its seems...

Of course there's more to our new design than the ability to switch between active and passive modes. In a similar way to the original Pro Series Two, the crucial main buffer/gain stage uses low impedance circuitry around a high-performance 5534 type op-amp and employs a relatively low resistance potentiometer (20k) as the volume control. This overall arrangement allows the preamp to deliver an excellent noise and distortion performance (see specifications box) while in its normal 'bypass' mode, with only a modest rise in the noise figure when the volume control is in its middle range.

We have also elected to provide remote control capability for the volume control only, and left the (much less used) tone controls and input switching sections to traditional manual methods. If IR remote control were used for the signal input switching for example, the only real way to ensure that this was noise and distortion free would be to use a large number of relays to replace each conventional rotary switch — a cumbersome and expensive arrangement, which would be very difficult to justify for this design.

Other than that, in line with the high performance theme of the preamp, we've deliberately used a motor-driven volume pot for the remote control feature, so that only a normal passive control appears in the audio path rather than some form of *active* attenuator circuitry. Also, the headphone amplifier is based on a further pair of 5534 op-amps rather than some form of hybrid op-amp/transistor stage or an IC power amp, and as a result delivers extremely clean signals to the headphones.

Since relatively few people require a phono stage nowadays, the RIAA phono preamp has been arranged as an 'optional extra' with the Pro Series Four. While the unit's input and recording selector switches have 'phono' positions marked, the separate phono preamp board can be omitted and that switch position used as an additional line-level input. And by the way, despite its relatively simple circuit the phono preamp itself performs well, and should suit all but the most demanding 'phonophiles'.

The last, but definitely not least, new feature of the preamp is its simple and neat construction, which makes the unit extremely easy to put together. The main change here is that we have used common IDC cable to pass the audio signals between the rear input sockets and the front mounted circuit boards and input selector switches.

With this setup the signal wires are arranged within the cables so that every alternate wire is at ground potential, so as to provide shielding and avoid crosstalk. Each cable simply plugs into the preamp's circuit boards via standard IDC header plugs and sockets. As a result there is no fiddly wiring to be completed between the input sockets and selector switches, for example, which makes the preamp very easy to assemble and service.

Other than that, virtually all of the components used in the preamp mount directly on three small circuit boards which in turn mount onto the front or rear box panels. So as you may imagine, there is very little interwiring to be completed inside the case.

That's the background to our new Pro Series Four preamp. We feel confident that it should have broad appeal to those constructors interested in a high quality preamp that delivers an uncompromising performance, but at the same time offers a useful range of features and is easy to put together.

It's also very pleasing to be able to report that so far, it looks as if kits for the new preamp will be priced at

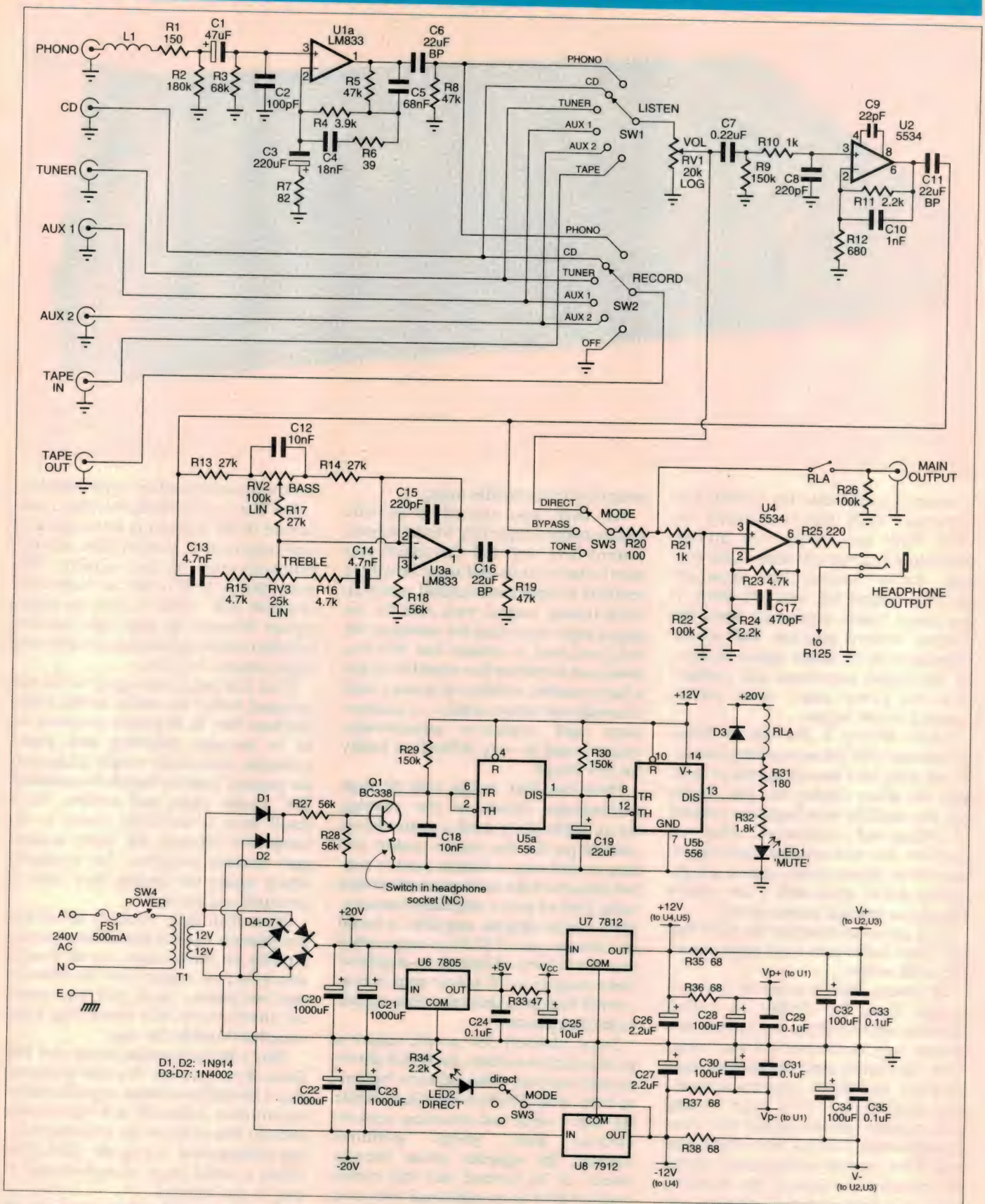
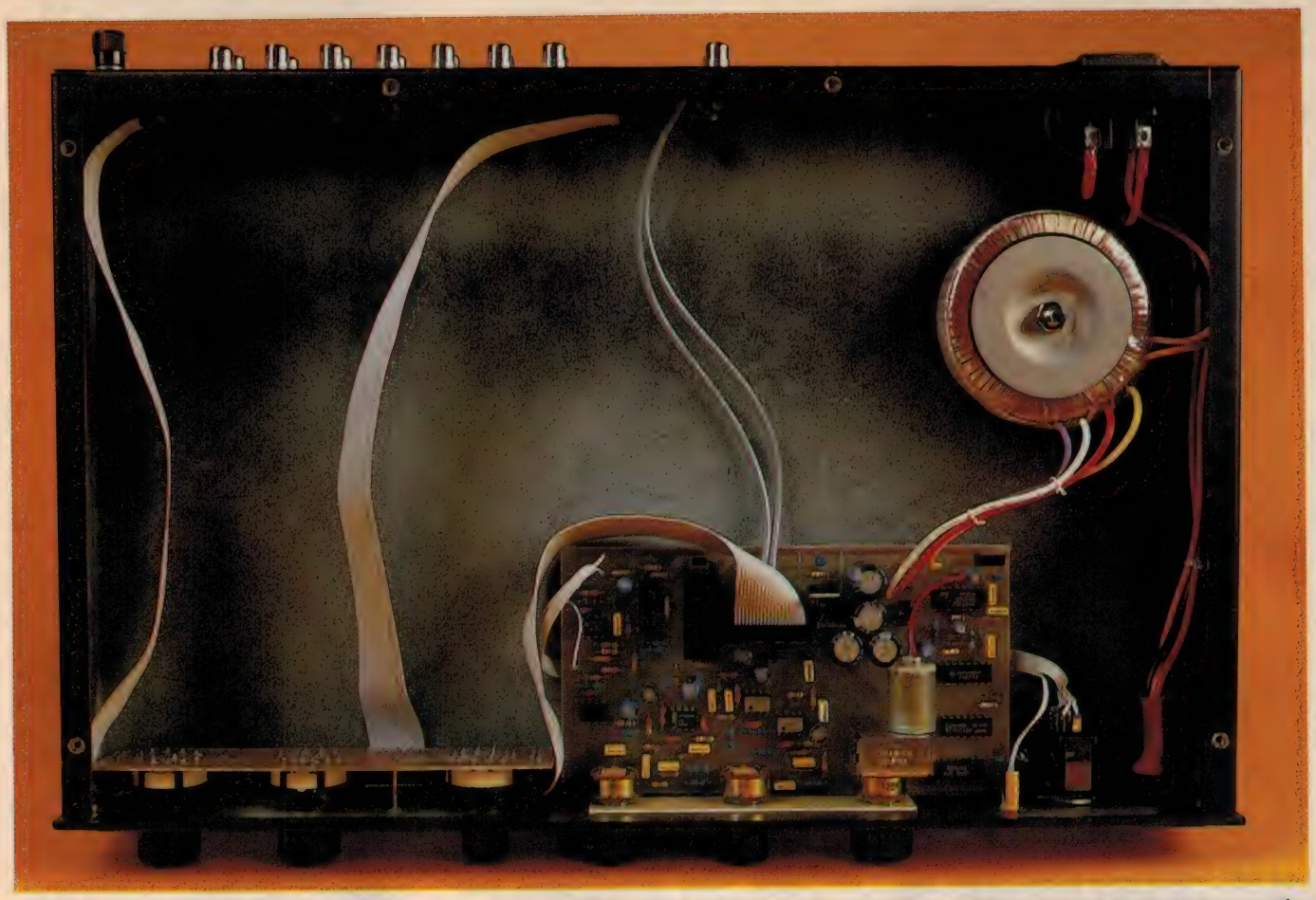


Fig.1: The main schematic diagram for the preamp. The audio section of the circuit (upper area) uses 5534 op-amps in the buffer/amp and headphone stages, while the tone and optional phono stages use LM833 dual op-amps — note that only one audio channel is shown.



The internals are very neat and uncluttered since standard IDC cable has been used to pass signals between the preamp's three small circuit boards, rather than numerous lengths of shielded cable. Note that the phono preamp board had not been installed when this photo was taken.

roughly the same figure as the earlier Pro Series Two preamp. Since that design was published way back in 1990 and inflation has marched on regardless, this sounds as if the new design should be excellent value for money.

Circuit details

As you see from the main schematic diagram (Fig.1), the preamp uses a fairly conventional arrangement for the audio path, which involves U1 as the (optional) phono preamp, U2 as the main buffer stage, U3 to implement the tone controls and U4 as the headphone amplifier. Other than that, selector switches SW1, SW2 and SW3 are used to choose the input signal, recording output signal and operating mode, respectively.

Tracing a signal though the circuit, you can see that an input signal selected by SW1 ('listen') is passed directly to the main volume control RV1, then on to the main buffer/gain stage based on U2, via C7 and R10. Here, C7 in conjunction with R9 sets the low frequency rolloff point to about 5Hz, while the low-pass action of R10 with C8 defines an upper frequency point of around 700kHz. This latter figure is set to well above the nominal audio band, since both the source impedance of the input signal and setting of RV1 will increase the effective value of R10, thereby reducing the high-frequency rolloff point. For example with RV1 set at maximum and a signal source impedance of say 10k, it would drop to around 100kHz.

The following 5534 low-noise op-amp stage (U2) then amplifies this filtered signal by a factor of around four (12dB), as set by feedback resistors R11 and R12. Further tailoring of the stage response is provided by compensation capacitor C9, and the first-order low-pass action of C10 in conjunction with R11 (around 70kHz). Output coupling capacitor C11 then passes this amplified signal to a fairly conventional Baxandall feedback tone control stage based around the LM833 op-amp, U3.

Here, the treble-shaping network is composed of C13, R15, RV3, R16 and C14, and through a frequency selective voltage divider action alters the op-amp gain over a (roughly) +/-12dB range. By way of explanation, if you consider both C13 and C14 as a short circuit for the moment — as is the case at high frequencies — the circuit can be reduced to a conventional inverting amplifier stage, where the gain is set by the ratio of the total resistance on either side of RV3's wiper.

Bass levels are tailored in much the same manner via the network composed of R13, R14, RV2 and C12. Here for analysis purposes you can consider C12 to be an open circuit at low audio frequencies.

The other tone control components include R17, which helps to isolate the two networks (to reduce interaction between the tone controls), and C15 which applies high frequency rolloff above the audio band. This latter addition reduces the level of potentially harmful ultrasonic (or higher) frequencies reaching the power amplifier when the treble control has been adjusted for a high level of boost.

The output signal from U3 (pin 1) is then passed to the mode select switch SW3 via coupling capacitor C16, then on to the main preamp output through isolating resistor R20 and muting relay contacts RLA.

As shown in the schematic, the main

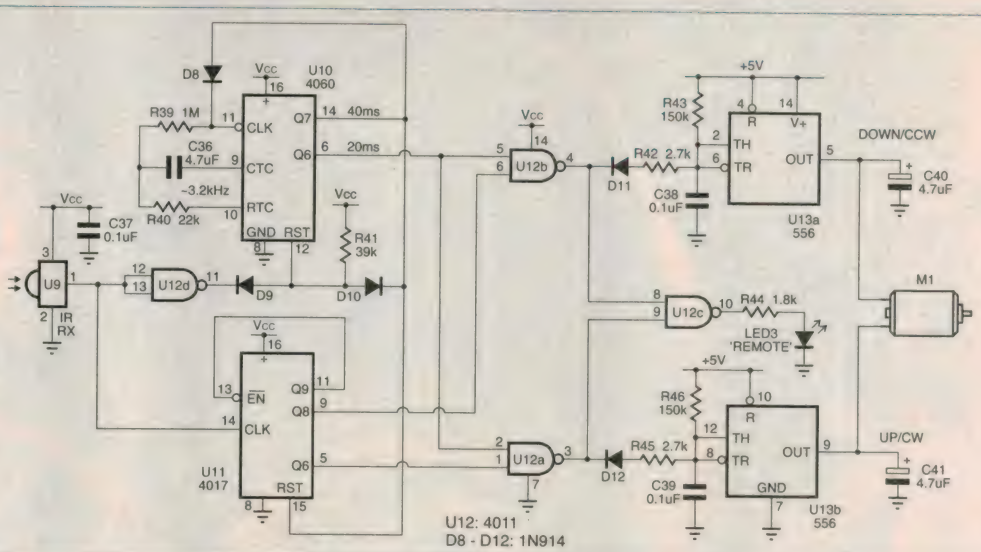


Fig.2: The new preamp's remote volume control circuit is virtually identical that used in the 'Infrared remote volume controller' presented in the July '96 issue. U9 is an infrared 'front end' IC, counters U10 and U11 decode the volume up and down instructions, while a dual 556 timer IC (U5) is used as a bipolar driving stage for the volume pot motor M1.

output signal (before the muting relay contacts) is also passed to the headphone amplifier based on a further 5534 op-amp, U4. This stage is is configured for a gain of about three (10dB) by feedback resistors R23 and R24, and drives the headphone outlet via limiting resistor R25. The remaining components include R21 and R22, which serve to both isolate and reference U4's non-inverting input, and C17 which restricts the headphone amp bandwidth to around 70kHz.

Returning to the preamp's input circuitry, you can see that with the exception of the tape input socket, any of the available inputs can be switched directly to the tape output socket by the 'record' selector SW2, which operates independently from the 'listen' selector SW1. The recording output is disabled when SW2 is moved to the 'off' (tape) position, as this would otherwise constitute a positive feedback loop when the tape machine is placed in its recording mode.

The phono preamp circuit is (again) a relatively conventional arrangement using an LM833 op-amp. RIAA equalisation is applied via the negative feedback network based on R4 to R7, and C3 to C5. These have been selected for a reasonably low overall network resistance, to reduce noise through the stage, and also set the gain to around 35dB at 1kHz.

Phono signals are applied to U1 via a number of filtering components, including inductor L1 (approximately 10uH) to reduce the effects of stray RF energy; R1, which acts as a further high-frequency filter in conjunction with C2; and electro C1, which helps to reduce the level of subsonic signals applied to the amplifier stage. The amplified and filtered signal appearing at the output of U1 (pin 1 or 7) is then passed to the following line-level circuitry via coupling capacitor C6.

The remaining part of the audio path involves the mode select switch SW3, which simply routes the signals through the appropriate stages as defined by the three operating modes. As you can see, the 'direct' mode shunts signals from the wiper of the volume pot directly to the main output (avoiding all active stages); in 'bypass' mode the audio passes through just the high-performance buffer/amplifier stage (U2); while in 'tone' mode all stages are included. Not surprisingly, there is a significant drop in output level from the preamp when the direct mode is selected, since the overall preamp gain falls from around 12dB to 0dB.

Power supply

The lower section of the main schematic (Fig.1) shows the preamp's power supply and signal muting circuitry, where U5 controls the action of muting relay RLA and three standard regulator chips (U6 to U8) are used to derive the various voltages needed by the preamp's circuitry.

In detail, the 240V mains is applied via power switch SW4 and fuse FS1 to power transformer T1, which in turn drives bridge rectifier D4-D7 from its (nominally) 24V centre-tapped secondary winding. The resulting +/-20V DC rails are filtered by reservoir capacitors C20 to C23 and applied directly to three-terminal regulators U6 to U8.

The 7805 regulator U6 is used to generate the +5V and Vcc rails required by the infrared remote control section (see later). Here C24 acts as a high-frequency bypass for the +5V rail and filter components R33 and C25 are used for the Vcc supply, which powers the more sensitive parts of that circuit.

Regulators U7 (7812) and U8 (7912) are then used to derive the preamp's main +/-12V rails, which are in turn heavily filtered and bypassed by R35, C32, C33 and R38, C34, C35 to produce the V+ and V- rails, respectively. This filter arrangement is duplicated for the Vp+ and Vp- rails (phono preamp supply) using components R36, R37 and C28 to C31, while tantalum capacitors C26 and C27 provide output bypassing for the 12V regulators.

The -12V rail is also used to power the 'direct' mode indicator (LED2) via limiting resistor R34 and one section of the mode switch SW3. This causes LED2 to illuminate when SW3 is moved to the 'direct' position, thereby alerting the user that this mode has been engaged.

Muting circuit

Finally, the output signal muting circuit based on U5 uses the same basic circuit arrangement as that in the Pro Series 2 preamp, except that we have elected to use a dual 555 timer IC to derive the timing periods, rather than the number of discrete transistors and zener diodes used before. In basic terms, the relay's action is controlled by two timing periods, where timer U5a is used to disengage the relay (signal mute) and responds in a few milliseconds, while U5b delays the relay engaging action by a number of seconds.

Perhaps the best way to look at this part of the circuit is to first consider

the action of just U5b during a power-on cycle, while (for the moment) ignoring the effect of U5a.

When the +12V and +20V rails are activated as AC power is applied to the preamp, C19 will be in a discharged state. This holds both the threshold and trigger inputs of IC5b (pins 8 and 12) at a low level, thereby forcing the timer into a 'triggered' or ON state. As the IC's internal discharge transistor at pin 13 is switched off as a result, there will only be a small current flowing though the relay coil via R31, R32 and LED1. The relay is therefore disengaged (signal mute), and LED1 will illuminate to indicate a 'mute' condition.

C19 will then slowly charge towards the positive supply rail via R30, until the voltage at pin 12 and 8 reaches U5b's 'threshold' point of 2/3Vcc (around 8V in this case). Then the chip will reset, turning on the internal discharge transistor at pin 13. The now low level at pin 13 will energise RLA via limiting resistor R31 (muting off) and effectively short out the R32/LED1 combination, extinguishing the 'mute' indicator. So for the first couple of seconds after power is applied to the preamp, the main output signal is disconnected.

To understand the circuit's action when AC power is disconnected or interrupted however, we need to consider the action of Q1 and U5a. This part of the circuit is able to instantly detect an interruption in the AC supply, by monitoring the raw AC signal at the secondary winding of T1 via diodes D1 and D2. The rectified — but not filtered — signal that appears at the diode cathodes is applied to the base of NPN transistor Q1 via divider/limiting resistors R27 and R28. As a result, Q1 is biased hard on when the drive signal exceeds around 0.6V.

As the applied signal moves between 0 and around 20V in a rectified AC manner (at 100Hz), there will be a period of only a few milliseconds in each cycle when Q1 is off. Note that the headphone switch contact shown on the diagram is normally closed, and Q1's emitter can be considered as connected to ground.

During these relatively brief periods when Q1 is off, C18 will be allowed to charge towards the +12V rail via pullup resistor R29, but will be immediately discharged when Q1 returns to its 'on' state. If the 'low' time of Q1's drive signal exceeds *more* than a few milliseconds however (say, the AC supply is switched off), the voltage across C18 will have sufficient time to rise to much higher value.

Since this rising voltage is also applied to both the threshold and trigger inputs of U5a — which is normally in its triggered or on state — the timer chip will be reset when this voltage reaches two thirds of the supply rail (as with U5b, around 8 volts). This in turn will switch on the timer's 'discharge' transistor at pin 1, which rapidly discharges C19 and *restarts* U5b's mute timing cycle — as described above.

The advantage of this type of 'intelligent' mute circuit is that the preamp's output signal will be shut off for a fixed period, regardless of how brief the power interruption may have been. With most simpler muting circuits the timing capacitors will not fully discharge during a momentary power interruption, and this leads to a very short (or non-existent) muting action and possible speaker/amplifier damage through the resulting amplified transients.

As also shown on the schematic, the headphone socket's set of normally-closed contacts are wired into Q1's emitter circuit, which will therefore be isolated from ground when a set of headphones have been plugged in. As C18 can no longer be discharged by Q1 in sympathy with the AC source, the circuit will go into its 'muting' state while this condition remains — note that C19 is held in a discharged condition by pin 1 of U5a.

The idea, of course, is that plugging in the headphones mutes the main preamp outputs.

Remote volume control

Fig.2 shows the circuitry used for the preamp's remote volume control stage. As you may have noticed, this is virtually identical to that used for our 'Infrared remote volume controller' presented in the July 1996 issue of *EA*. This uses a relatively small number of low-cost parts, employs a infrared (IR) code system that is compatible with 'learning' IR transmitters, and generates no detectable interference signals in the audio path.

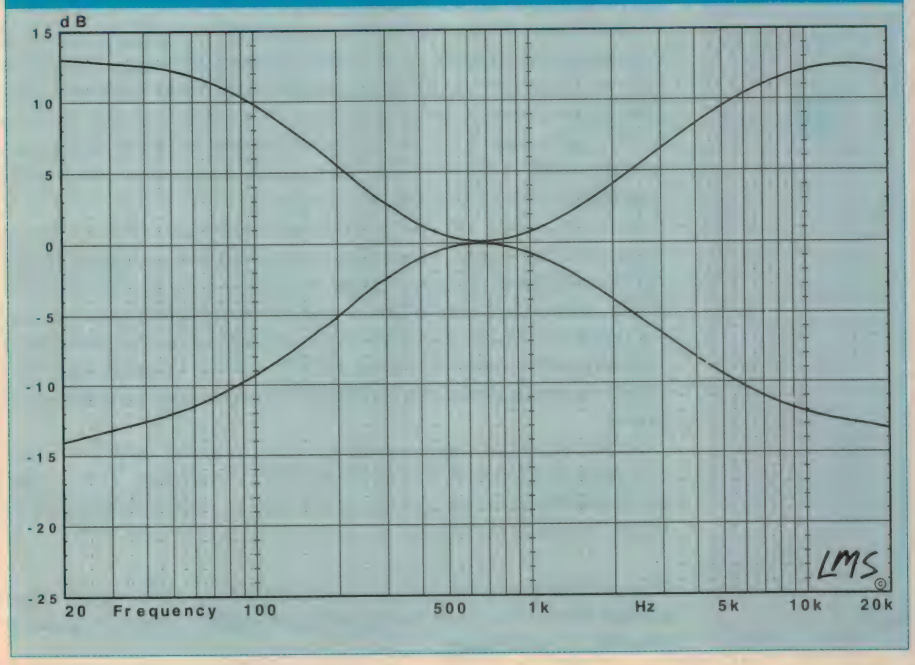
For a detailed description of how this circuit — and its matching transmitter — operates, we would recommend that you refer to the abovementioned issue of *EA*. The only real change from that circuit is the addition of filtering capacitors C40 and C41 at the motor drive outputs; these reduce the possibility of motor generated interference signals (that is, brush noise, etc) and stabilise the behaviour of some brands of 556 timer ICs.

In broad terms however, IR signals are received and demodulated by the IR 'front-end' sensor chip U9, decoded by counter chips U10 and U11, and resolved into volume up and down instructions at gates U12a and U12b, respectively. These are in turn used to trigger the pulse-stretching stages based on U13a and U13b, where the high output current capability of the 556 chip is used to drive the volume pot motor (M1) directly.

That's about all we have space for in this issue. In the next and final installment, we'll deal with the Pro Series Four's construction and preliminary checks. We'd like to thank Jaycar Electronics for their assistance in developing this project.

(To be continued.) ❖

PRO SERIES FOUR PREAMP — Tone Control Range



Construction Project:

MINIOSC: A POCKET SIZE AUDIO OSCILLATOR

Here's a high performance audio oscillator design that is small enough to fit literally in a shirt pocket — let alone in a service technician's toolbox. Despite its tiny size, it produces low distortion sine or square waves at any frequency from 41Hz to 18kHz, and runs from a standard 9V battery.

by PHIL ALLISON

This new oscillator, dubbed the Miniosc, could be called 'Son of LDO' because the basic circuit design derives from my 'Low Distortion Oscillator' project, published in the February and March 1989 issues of *Electronics Australia*.

Some time after that design was published, it occurred to me that an even simpler, battery operated version was possible and could be made at very low cost as well by using a single quad op-amp to provide the entire active circuitry. Employing a 9V battery supply would put a lower limit on the maximum output level, compared with the mains powered LDO, but would still mean that about one volt or so output should still be available. And that's how this new design came about.

The mini version of the LDO has been fitted into a pocket sized instrument case, including a nine volt battery in its own compartment. It has level and frequency control pots on top with range and mode switches on the sides — allowing one-handed operation of all controls, a very useful feature.

A mini sized, battery powered sine and square wave source is invaluable for on-site testing of all sorts of audio equipment. It can also be an advantage for workshop use where the item to be tested may not fit on the workbench — for example a 24 channel mixing console or a large powered loudspeaker system.

The author's prototype, shown here about 20% larger than actual size. It's very compact and easily slips in a shirt pocket, if necessary.

Circuit description

For the benefit of those readers who may not have seen the earlier Low Distortion Oscillator design, a simplified outline of its operation follows. For a more detailed description see the February 1989 edition or arrange for a photocopy of the article through EA's Reader Services department.

The oscillator circuit (see Fig.1) involves two unity gain phase shift stages, A1 and A2, in tandem and a gain stage, A3, with back to back diodes and resistor network providing non-linear negative feedback. At a particular frequency (see note 1) A1 and A2 provide 90° phase shift each, 180° in total and the circuit begins oscillating since A3 and its non-linear network has more than unity gain for small signals. As the oscillation level increases the diodes conduct and limit the gain of A3, stabilising the output at the desired level — in this case a little over one volt RMS. However, some distortion of the sine wave peaks is caused by the diodes.

The fourth stage, A4, is the real secret of the design since it combines the outputs of the three preceding stages in such a way as to reduce the third and higher-order odd harmonic distortion products generated in those stages due to the back to back diodes used for level stabilisation. Because the diodes are symmetrical in their effect they cause only third and higher odd harmonics of the sine wave output.

The net effect of A4 is to remove at least 90% of these unwanted harmonics from the output over the operating range of the oscillator. The prototype measured only 0.16% THD at 1kHz, somewhat less at lower and more at higher frequencies. At these levels the distortion is barely audible and presents a visually perfect sine wave on a CRO screen. Overall, this represents a much better performance than a typical function generator.

Refering to the main circuit (Fig.2) there are only two control pots (RV1 and RV2) and two DPDT switches. The output level pot includes an on-off switch and is of logarithmic taper to allow easier setting at low (i.e., millivolt) levels. This pot is

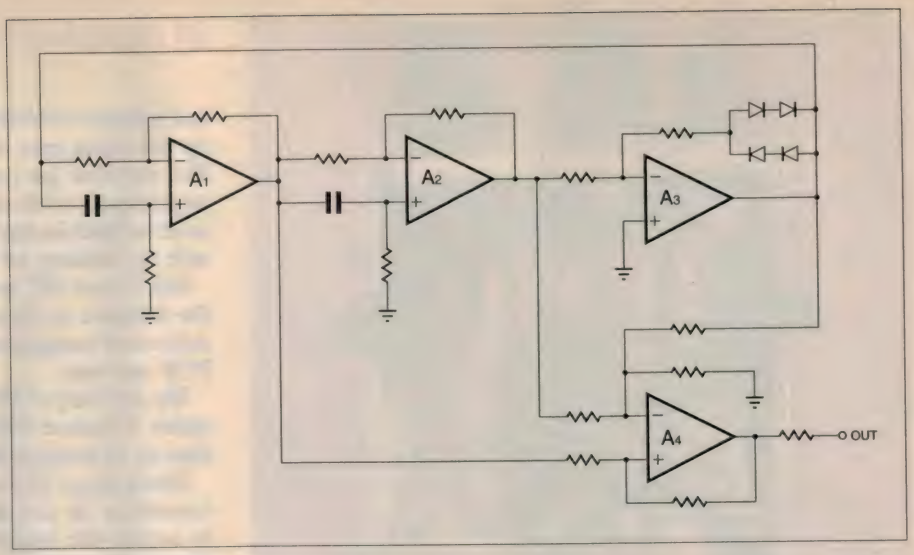


Fig.1: The basic oscillator configuration used in the Miniosc. The output stage around op-amp A4 is the key to its low distortion.

directly coupled to A4's output to minimise response errors, provided that the load impedance is constant or quite high compared to the output impedance provided by Miniosc.

The 'sweep' or frequency adjust control has a range of about 24:1 and is used in combination with the Hi-Lo range switch which has an 18:1 ratio. This allows coverage of the entire audio band, with the exception of the lowest octave, in two overlapping ranges. The possibility of a single sweep of the audio band without the range switch was tried out, but later dropped in preference to the present design.

The square/sine wave switch works by disconnecting the negative feedback around A4, allowing the op-amp to run 'open loop'. In this condition it is overdriven by the oscillator stage, causing its output to saturate at the positive and negative supply voltages producing a squared waveform.

The additional four-diode network which is switched across the output of A4 is used to limit the output voltage level in square wave mode to match the sine wave level, and at the same time regulates against variations in the battery voltage.

The actual operating level of Miniosc is limited by the use of a single 9V battery. The discharge curves for various types show a voltage variation of from 9.5 volts down to 6.3 volts is to be expected from 'fresh' to 'flat'. The Miniosc operates as specified over this range with a maximum output level of 1.27V RMS sine and 1.45V square.

The battery drain in sine wave mode is a miniscule 1.7mA, increasing to about 4.7mA in square wave mode. This very low drain is mainly the result of using the Texas Instruments TL064 low power quad FET op-amp, which is ideally suited to the design.

Types like the TL074, TL084, LF347 and LF444 and other quad op-amps with compatible pinouts are not recommended for use, due to both the increased battery drain and reduced margin of minimum operating voltage. The TL064 is alone in having operation specified down to a +/-3 volt supply.

Power from the standard nine volt 216 style battery feeds a voltage divider (R16 and R17) to provide an artificial centre-tap, with bypass capacitors and a 1A diode to protect the IC from inadvertant reverse connection of the battery. Even a momentary reversal of a good battery would easily destroy the TL064 IC and any of its relatives.

Creating balanced +/-4.5V supply rails like this allows direct coupling between all the op-amp stages, including the output level control, and also reduces the number of components.

Performance

The Miniosc is NOT a toy oscillator. It is capable of serious work testing domestic or professional audio equipment of all types and will verify normal operation, allow levels to be set, channels to be matched and response curves measured.

Low distortion combined with a particularly high 'envelope stability' of 0.1dB, even when rapidly swept, is a feature lacking even in many high grade oscillators. Battery operation eliminates the possibility of mains hum in the output, and also allows connection to either floating transformer or actively balanced input circuit. Direct coupling of the output circuit eliminates any response errors caused by connecting low load impedances to Miniosc.

Note: The lowest octave of the audio band has been deliberately 'designed out', so as to avoid damaging speakers when using the Miniosc. There are few speaker systems that can safely accept full power input at 20Hz!

The square wave function has been included because it is so useful. The rise and fall times are relatively slow, but there is very good waveform symmetry across the audio range.

Performance of Prototype

Frequency Range:	
	Lo 41 to 1082Hz
	Hi 735Hz to 18.1kHz
Output:	1.27V RMS sine (+4dBm) (note 3)
	1.45V peak square
Load:	1.0V RMS sine into 330 ohms
Flatness:	+/-0.1dB (1%), 41Hz to 17kHz
Distortion:	0.16% THD at 1kHz
Square wave:	Risetime 5us at 10kHz
Symmetry:	1% up to 10kHz
Supply:	6.3V minimum
Consumption:	1.7mA sine wave
	4.7mA square wave

Construction

The specified case has a removable top panel, which should be carefully drilled as shown in Fig.4 and the two pots and BNC socket fitted. There is only just enough room, so measure twice and cut once! The pots may need the last few millimetres of their shafts removed to allow the knobs to sit flush as on the prototype. Use a hacksaw and file delicately to achieve this, also pack the slot in the shaft while cutting.

The two slide switches fit into slots which are cut with a nibbling tool in the sides of the case and then filed to size. Cut only enough plastic to permit full travel of the actuator. Two small holes will also need to be drilled to mount these switches. Mark their positions using a switch as a template and a sharp point or scriber. Four 2mm x 10mm long mounting bolts will also need to be purchased, as they are not supplied with the switches.

The PCB may now be loaded using Fig.3 as a guide. This work should be done carefully, to avoid solder bridges

Fig.5: Use this view inside the case as a guide to assembling your own.

and prevent overheating the components. Use a small conical tip soldering iron at a moderate temperature (about 320°C). The resistors are mounted vertically and the diode networks require pairs of diodes to have their leads twisted together and soldered before installation in the board. Take particular care with the polarity of the diodes and orientation of the IC.

MKT type PC mount capacitors have been specified for the Miniosc as they are now widely available. But no other miniature components are needed, despite the very small PCB and case.

Tip: Be wary of 1% metal film resistors with four-band colour codes. It is more reliable to measure them with your multimeter than try to decipher the codes.

Small areas of the PCB may need to be removed near the corners to fit into the case. A hole also needs to be drilled to secure the board with a 2.5mm (or 6BA) bolt, nut and insulating washer.

Link the pots and switches to the appropriate points on the PCB (see Fig.3) with short lengths of light gauge hookup wire, which should be attached to the PCB first if not using pins. Lastly, wire the battery snap via the on-off contacts on the level pot. It doesn't really matter which lead (red or black) goes to the switch, but red is traditional.

Finally, glue a small piece of foam plastic in the battery compartment to prevent the battery rattling about.

BNC output connector

The BNC output socket has been specified for the simple reason that the mating plug locks in place. An RCA socket was

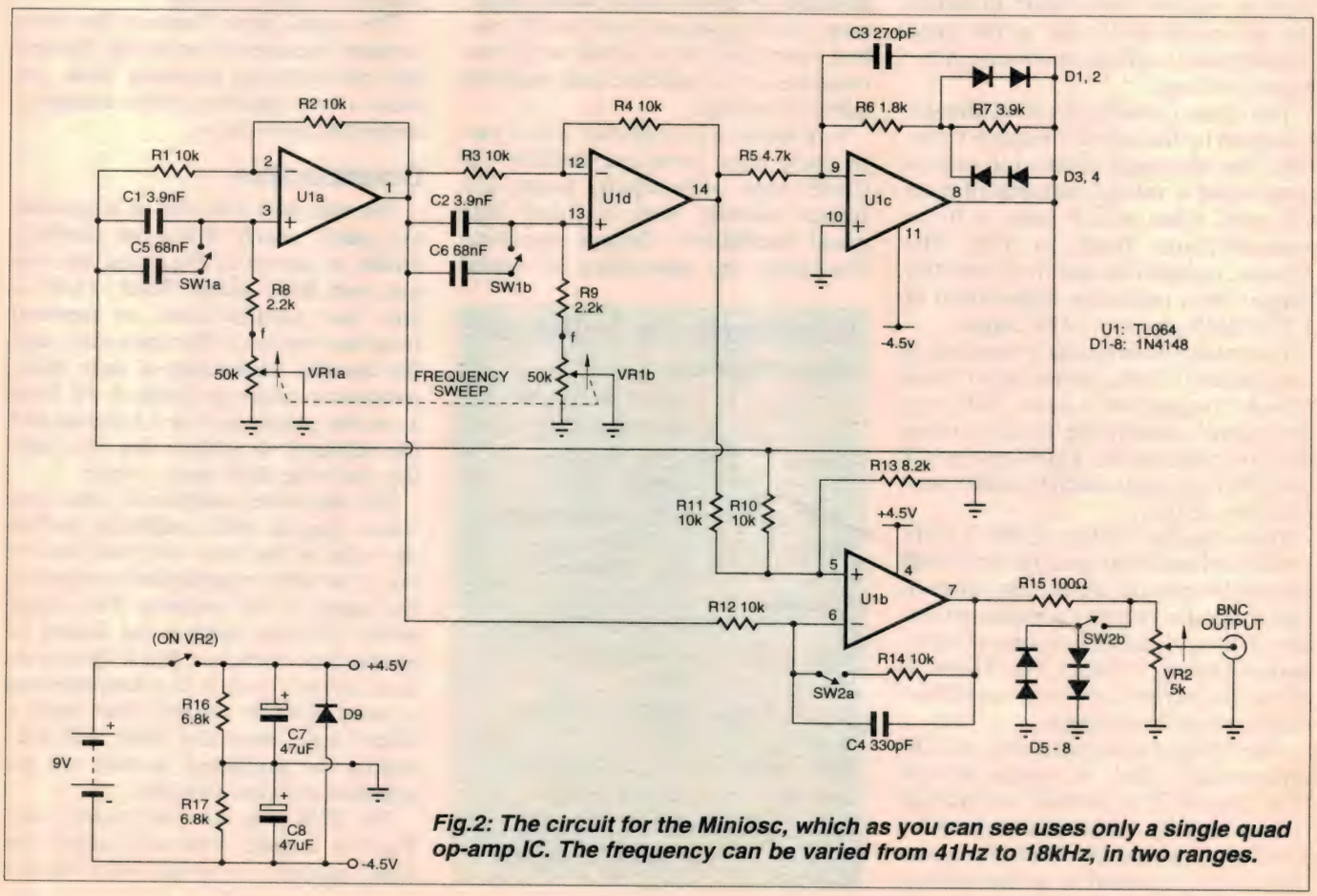


Fig.2: The circuit for the Miniosc, which as you can see uses only a single quad op-amp IC. The frequency can be varied from 41Hz to 18kHz, in two ranges.

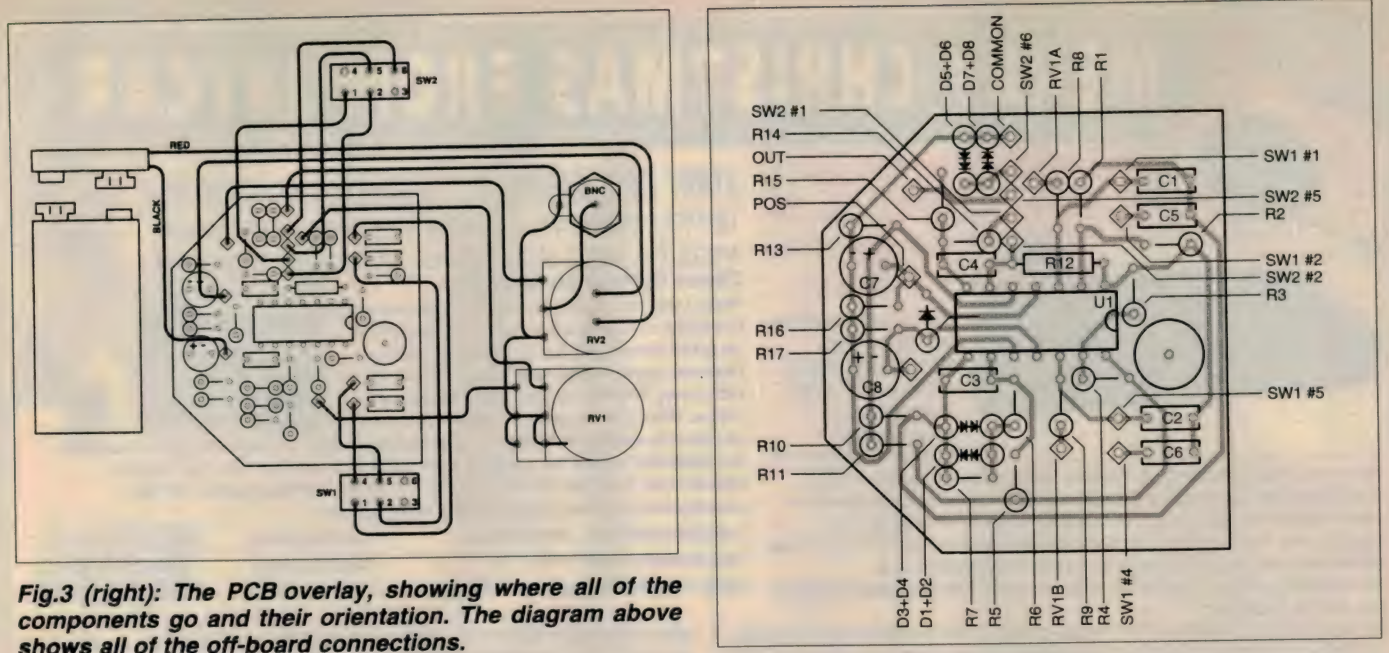


Fig.3 (right): The PCB overlay, showing where all of the components go and their orientation. The diagram above shows all of the off-board connections.

tried at first, but proved unsatisfactory since the Miniosc could not be left dangling on its output lead without risk of disconnection — followed by the unit hitting the floor with a somewhat disconcerting 'bang'! Using the BNC overcomes this problem and various adaptor leads allow easy conversion to RCA and jack plug connectors when required.

Commissioning

Once assembly is complete, double check all wiring and soldering, especially for bridges between tracks or IC pins.

Connect a battery and switch on. If you have a CRO available then a full performance check can be done; otherwise simply connect Miniosc to your stereo amplifier and operate all the controls to verify correct operation. The sweep should sound smooth and the pitch should increase as the knob is turned clockwise. A large increase in frequency should be heard when the range switch is moved from the Lo to Hi positions.

The square-sine wave switch should cause a very obvious sharpening of the tone, but little increase in the level. The top end of the 'Hi' sweep range should just disappear into inaudibility, unless you are much younger than I am!

Warning: Keep the level down for this last test, as replacement tweeters can be expensive!

High powered tests involving loudspeakers should always be mercifully brief.

The battery drain can be checked with a multimeter and should read around 1.7mA in sine wave mode if all is well and you are using the TL064. Excessive current drain or no oscillation will probably be due to wiring errors, solder bridges or a component or two which has not had one of its leads soldered.

Using Miniosc

Although the Miniosc is not intended to replace the usual bench audio signal generator, it can at a pinch do most of the same jobs a bench model does. The fact that the output level remains particularly steady while the frequency is swept rapidly makes response testing a breeze, especially for tape recorders, equalisers, electronic crossovers — and loudspeakers too, if a flat response sound level meter is available.

The main use I foresee for Miniosc is for spot tests on equipment where little or no other test equipment is to hand. This might mean using your ears as the output instrument, or possibly a VU meter, LED ramp or similar level display built into the unit under test. In many cases a digital or analog multimeter can be used as an output meter, providing that its response is known to be flat over the range to be measured or it has been checked first using your new Miniosc!

Warning about DMMs

Note that analog multimeters and VU meters will normally read accurately over the audio band, but the same is not true of most digital multimeters — where the AC readings taper off above only a few kilohertz.

Slowly turning the Miniosc sweep control makes pinpointing and tracing rattles and buzzes in speaker systems very simple. Also you can identify obvious peaks and holes in the response caused by defective drivers or passive crossover networks. Of course, be wary of rattling room heaters or window panes before you condemn the speakers.

Continued on page 77

PARTS LIST

Resistors

0.25W 1% metal film:

R1-4,R10-12,R14	10k
R5	4.7k
R6	1.8k
R7	3.9k
R8,9	2k or 2.2k
R13	8.2k
R15	100 ohms
R16,17	6.8k

Capacitors

C1,2	3.9nF 100V MKT
C3	270pF ceramic disc
C4	330pF ceramic disc
C5,6	68nF 100V MKT
C7,8	47uF 25V RB electro

Semiconductors

D1-8	1N4148 signal diode
D9	1N4004 power diode
IC	TL064CN quad low voltage op-amp

Miscellaneous

RV1	5k log/switch, 17mm
RV2	50k dual linear, 16mm
SW1,2	Sub-mini slide switch

Plastic instrument case, 96 x 61 x 25mm 'Pak-Tec' with battery compartment (RS Components 502-095; Farnell 148-580 in beige or 249-993 in PC bone), or equivalent size; PC board for miniosc, 45 x 48mm; BNC socket, single hole panel mount type; two push-fit knobs to suit pots; 4 x 2mm screws, 1 x 2.5mm nut, bolt and insulating washer; 9 volt battery and snap.

MERRY CHRISTMAS FROM JAYCAR

FABULOUS NEW PLAYMASTER PRO SERIES IV PREAMP

REF: Electronics Aust Dec 96 / Jan 97
KIT AVAILABLE JANUARY 1997

This totally new preamp is the ultimate development from the Series II preamp. In keeping with customer feedback and industry trends the preamp features simple to operate preamp-out-to-record facilities. (eg. to tape, recordable CD or other media). The preamp also features five, yes 5, line level inputs as well as phono. This extra line level input effectively gives you the opportunity to permanently convert audio from video sources without extra (& messy) line switch boxes etc.

Another fantastic feature is the remote control volume adjustment. Now you can control listening levels from the comfort of your favourite chair! (You can operate the volume normally as well.) The Jaycar & EA Staff co-operated very closely on this project. We, for example, provided the prototype componentry. It goes without saying, then, that we know what should and should not go in the kit! Not only is the Jaycar kit true to the prototype, in keeping with the Jaycar quality approach we include at no extra charge, quality metal film (not cheap carbon) resistors, the quieter 5534A op-amps, quality IC sockets and gold plated RCA's for all input and output connections! There is a nasty rumour going about that one major kit supplier will be supplying a cheap chassis transformer in lieu of the quality toroid as used in the prototype. BE ASSURED, JAYCAR CUSTOMERS, THAT WE WILL BE PROVIDING THE ORIGINAL, QUALITY TOROID IN OUR KIT - BEWARE OF CHEAP COMPROMISE KITS.

But there is a cost saving plan in our kit, however. In order to keep the kit cost down, Jaycar will not be providing an expensive IR remote especially designed for this kit. Instead we provide a PCB based "mini kit" which you can use to reprogramme existing learning remotes which you might already own. (If you don't the AR-1710 $43.95 or our AR-1705 $69.95 are ideal). We are accepting orders for this kit for late January delivery. Get in early as we are convinced that this will be in great demand!

SEE THE SPECIFICATIONS - UNBELIEVABLE!!!
•FREQUENCY RESPONSE (Line inputs, typical load) •Direct mode: unrestricted •Bypass mode: 15Hz to 30kHz +0/-1dB •Tone mode: 20HZ to 20kHz +/-1dB with controls set to 'flat' TOTAL HARMONIC DISTORTION (20KHZ bandwidth, typical load, at 1VRMS output) •Direct mode: unmeasurable •Bypass mode: less than 0.002% •Tone mode: less than 0.002% SIGNAL TO NOISE RATIO (20KHZ bandwidth, unweighted, at 1VRMS output) •Direct mode: unmeasurable •Bypass mode: -105d •Tone mode: 100dB or better, depending on tone setting CHANNEL SEPARATION (1k source termination, 1VRMS reference) •Direct mode: 96dB at 100Hz, 84dB at 1kHz, 70dB at 10kHz •Bypass mode: 92dB at 100Hz, 81dB at 1kHz, 63dB at 10kHz •Tone mode: 92dB at 100Hz, 81dB at 1kHz, 60dB at 10kHz •INPUT AND OUTPUT LEVELS (volume control at maximum, line inputs) Direct mode: 1V in for 1V out, max output: unrestricted Bypass mode: 240mV in for 1V out, max output: 7VRMS •Tone mode: 240V in for 1V out, max output: 7VRMS OUTPUT IMPEDANCE (APPROX.) •Direct mode: 10k - 100ohms, depending on volume setting and input source impedance •Bypass mode: 100 ohms •Tone mode: 100 ohms TONE CONTROLS •Bass +/-12dB at 50Hz, •Treble +/-12dB at 10kHz OUTPUT MUTING •Turn on delay: approx. 2 seconds •Turn off delay: approx. 5 milliseconds

Cat. KA-1790 **Only $299 Complete**

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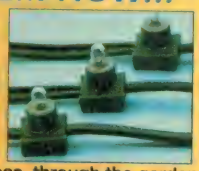
WITH OUR INDOOR/OUTDOOR LOW VOLTAGE LIGHTING SYSTEM NOW!!!

These lights look fantastic.



Make your own garden stand out from the rest!! Cliplights are completely pre-wired and come on a 100 metre reel. So, you simply purchase however many metres you require. There is one bulb every 300mm - so you get 3 bulbs per metre. The cable is green in colour. They are completely waterproof. Ideal to hang through trees, through the garden, around the verandah, under the pergola, over the christmas tree. Use our Tordidal transformer, Cat. No. MT-2112 at $52.95. There is enough power in this transformer to power 100m of lights (330 globes).

3 BULBS/METRE - PREWIRED	Cat SL-2810	$2.50/mtr
COLOURED CAPS - PKT 25	Cat SL-2812	$6.95/pkt
REPLACEMENT GLOBES - PKT 10	Cat SL-2814	$5.95/pkt

PC - CONTROLLED ARBITRARY WAVEFORM / FUNCTION GENERATOR KIT

REF: ELECTRONICS AUSTRALIA DECEMBER 1996

This project connects to your PC's parallel port to produce signals of virtually any desired waveform at frequencies below 0.25Hz to beyond 100kHz. The generator is software driven and will allow you to download waveforms from your PC and playback at the desired frequency. On-board RAM can store up to 32,768 bytes of waveform samples such as those produced by our Pocket Sampler Kit, KA-1787. Low cost software is available from the EA BBS or from the magazine direct (details supplied). The Jaycar kit is supplied complete with case, mains transformer, PCBs, professionally punched and silk screened front panel plus all specified electronic components, including a complete set of IC sockets for no extra cost.

Cat. KA-1792 **Only $99**

CABLE CLIPS

A new range of cable clips for 1997. They are made using a high-density polyethylene plastic material and galvanised high carbon steel nails are used. Available in packets of 25 and are priced up to 50% less than others.

5 SIZES AVAILABLE

3 x 5mm
Accepts cables up to 3mm high by 5mm wide. Ideal for the following cables - 4 core flat telephone, WB-1702 light duty speaker cable
Cat. HP-0680
$1.95 Pkt 25

5 x 8mm
Accepts cable up to 5mm high by 8mm wide. Suits the following cables - WB-1706 & WB-1708 speaker cable and 6 core flat telephone cable.
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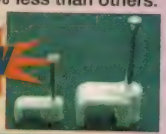
$2.75 Pkt 25

NEW



6 x 10mm
Accepts cable up to 6mm high by 10mm wide. Suits the following cables - 8 way flat telephone cable WB-1732 jumbo speaker flex and WB-1735 monitor speaker cable.
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5 - 7mm Expandable
Suits round cables with 5-7mm diameter - including 4 core alarm cable, 75Ω thin coax and 50 Ω thin coax.
Cat. HP-0692
$2.75 Pkt 25

7 - 10mm Expandable
Suitable for round cable 7-10mm diameter - including 6 core alarm cable, air spaced coax and Belden coax.
Cat. HP-0694
$2.95 Pkt 25

"A VERY MERRY CHRISTMAS TO ALL OF OUR VALUED CUSTOMERS FROM JAYCAR STAFF AND DEALERS".

OUTDOOR GARDEN LIGHTS

150 BULBS

Have the best looking garden in the street - 150 lights! These are bigger, better and cheaper than our previous model. Safe, low voltage (24V) supplied with a mains 240V plug pack. Completely pre-wired - simply hang them through your garden. The set consists of a 240 volt plug pack, 15 metres of cable then 21 metres of cable with the 150 globes at 140mm spacing. All cable and globe bases are green, so it easily hides in the garden. Current drain for all 150 globes is approx 2.1 amps. Replacement globes are available - Pkt 6 - $4.95 - Cat SL2832.

Only $69.95

Cat: SL-2830

Replacement globes for 80 light sets sold in 1993 are still available Pkt 5 - $2.95 - Cat SL2822.

12V CELLULAR PHONE / VIDEO BATTERY DISCHARGER, DEEP CONDITIONER & FAST CHARGER

First shipment sold out within days!!
Suitable for Ni-cad & Ni-mh cells.

Features:- •When battery is charged, switches to trickle charge •Discharges then automatically fast charges •Deep conditioning of Ni-cads with memory effect. Battery is automatically discharged and charged 3 times •Self test mode •Temperature sensor •Powered by 12V. For 240V use 1A mains adaptor. Cat. MP-3015 $22.95. Adaptors required for different batteries. Charger supplied with Motorola Microtac adaptor.

Other adaptors: All $12.95 each •Motorola 8000/9000/9800 7.2V - Cat. MB3555 •NEC P3/P300 6.0V - Cat. MB3556 •Ericsson 237/337 6.0V - Cat. MB3557 •Oki 700 6.0V - Cat MB3558 •Oki 900 6.0V - Cat. MB3558 •Nokia 2110 6.0V - Cat. MB3559 •Nokia 100/101/121 Cat. MB3560 Video Camera Battery Adaptors: •Sharp, Hitachi, Sony - Cat. MB3565 •Panasonic, Canon, JVC - Cat. MB3566

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REF: SILICON CHIP NOV + DEC 1996

NEW

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This stuff is $10/100m roll

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NEW

TAKES THE GUESS WORK OUT OF BATTERY CHARGING

This charger will charge all types of car/motorbike/boat etc 12 volt batteries. Features: **•Correct connection LED** - this will tell you if you have placed the chargers terminals on the correct polarity of the battery **•Charging LED** - lets you know the unit is charging your battery **•Fully charged LED** - tells you your battery is fully charged and ready to go. Comes complete with instructions printed on the case of the charger (so you never need to find that lost instruction booklet). •240 volt mains powered •Electricity authority approved •size: 148(L) x 140(W) x 70(H)mm •Easy to use

Cat. MB-3530 **$39.95** **"ALSO 8 AMP BATTERY CHARGER AVAILABLE SOON"**

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Cat. TD-2070 **$7.95**

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This precision knife set is supplied with three different sized handles and 13 blades. There is 10 different blades of varying sizes and shapes. Supplied in a plastic case.

Cat. HG-9940 **$14.95**

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This kit has everything for the hobbyist. The knife set includes three different sized handles and 21 assorted blades. Blades are kept in plastic tubes for safety. The mitre box is made from aluminium and is 138mm long, with a diameter of 40mm. The saw blade length is 126mm. A block sander is included, along with a scriber, tweezers and a small wooden wedge. All is supplied in a plastic case.

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HEAVY DUTY CABLE CUTTERS

NEW

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Cat. TH-1898 **$14.95**

25 PC ALLEN KEY SET

NEW

25 different size allen keys in a plastic wallet. There must be every size you would possibly need, in both metric and imperial sizes. •Metric: 1.27, 1.5, 2.0, 2.5, 3.0, 4.0, 4.5, 5.0, 5.5, 6.0, 7.0, 8.0, 10.0mm •Imperial 3/8, 1/4, 7/32, 3/16, 5/32, 9/64, 1/8, 7/64, 3/32, 5/64, 1/16"

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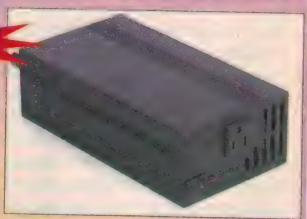
NEW

No more skinned knuckles trying to tighten awkward nuts and bolts. They are easily reversible by touching a tab on each end. They are offset, so the handle is raised, rather than flat, making them easier to use. Five double ended tools supplied, with the following sizes: 5.5, 6.0, 7.0, 8.0, 10.0, 11.0, 12.0, 13.0, 14.0 and 17.0mm

Cat. TD-2112 **$24.95**

300W 12 - 240V INVERTER

NEW



Brand new unit. Made by the same company who makes our 140W and 200W units. This unit is 300 watts continuous power, with peak power of 800 watts. Amazing power for its size. It measures only 205(L) x 115(W) x 65(H)mm and weighs only 1100 grams. Features •Low voltage protection •Overload protection •Over power protection •Temperature protection •Short protection •Polarity protection. Specifications •Input volts - 10-16VDC •Output volts - 230V AC RMS • Continuous power - 300W •Peak power - 800W • Output waveform - modified sine wave •Output frequency - 50Hz+/- 1% •No load current - 0.5 Amp •Efficiency - 85% typical •Weight - 1500 grams •Size - 205(L) x 115(W) x 65(H)mm

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NEW

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If you want a more comprehensive tool kit than the 40 piece, then this 100 piece should do the trick. Tools are heat treated. (see 40pc. kit for explanation on tool quality) Again, please note that these are not top brand tools, but you do get alot of tools for the money. Tool kit includes the following: •10x1/2" drive sockets (10-24mm) •1x1/2" drive sparkplug socket 21mm •1x1/2"drive ratchet handle •1x1/2"drive universal joint •1x1/2" drive 125mm extension bar •1x1/2" drive sliding Tbar •9x1/4" drive sockets (5-13mm) •8 combination spanners •4 hex allen keys (5-10mm) •1 water pump pliers 240mm maximum •1 vice wrench pliers 250mm max •1 crimping tool for lugs •39 el cheapo lugs •1 thickness guage •1x6-24V auto test screwdriver •5 screwdrivers •11 screwdriver bits-slotted, Philips,torx and posidrive •1 el cheapo hammer •1 T-handle screwdriver •all supplied in a plastic case.

Cat. TD-2102 **Only $49.95** NEW

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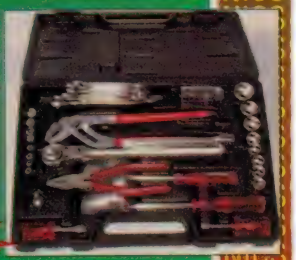
Cat. TD-2460 **$59.95**

40 PC TOOL KIT



Ideal tool kit for the "weekend tradesmen" or to have in the car boot for those times you need a tool. Be careful when comparing prices for these type tool kits, they may look the same, but there is a different quality level. There is the standard level, then vanadium. Our sets are heat treated, so whilst they are not the top quality level, they are not the lowest level either. Tools that are not heat treated are pretty poor. But please note: these are not top brand tools, you get a lot of tools for the money!! Kit includes the following: •9x1/4" drive sockets imperial (5/32 to 7/16") • 8x1/4" drive sockets metric (4 - 9mm) •1x3/8" flexible ratchet •1x6" cutting pliers •1x13/16" drive spare plug socket •1x3/8" (F) x 1/4" (M) adapter •6 combination spanners (5/16 to 5/8" and 8 to 17mm) •3 allen keys (1/16 to 1/4" and 1.5 to 6mm) •3 screwdrivers •1x6" extension bar •1 water pump pliers •1x1/4" drive spanner handle •All supplied in its own plastic case.

Cat. TD-2100 **Only $24.95** NEW

AA FLAT NI-MH BATTERY

These are the flat batteries used in the really thin celluar telephone batteries. Rated 1.2V 650mA Ni-MH. Japanese cell. Size: 47mm(L) x 14mm(W) x 7mm(H). Cat. SB-2435

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Construction Project:

PC-DRIVEN ARBITRARY & FUNCTION GENERATOR -1

Need to generate signals with special waveforms, for testing? Here's the design for a PC-driven unit that will cost you much less than commercial function or arbitrary waveform generators, but can produce signals of virtually any desired waveform at frequencies from 0.25Hz to beyond 100kHz. It's based on a novel technique, derived from direct digital synthesis.

by JIM ROWE

Commercially available 'function' generators will typically set you back about $400 or more, and will generally only produce sine, square, triangular and perhaps sawtooth waveforms — up to about one or two megahertz. While this kind of price tag is perhaps not too unreasonable, it can still be a bit daunting if you only need such test waveforms every now and again, and for many of us this is the case.

It's even worse if you want to be able to generate more complex or specialised waveforms. Here you enter the realm of arbitrary waveform generators, or 'arbs' — and both pricing and complexity climb rapidly into the stratosphere. Another drawback, at least with all of the arbitrary waveform generators that I've come across to date, is that they can be incredibly complicated to use.

So what options *do* most of us have, when we need to generate some kind of special test waveform? Not many, until now. You can rent a function or arb generator, of course, but this can work out to be quite expensive if you need it for a while. Or you can try building one of your own...

Back in the January 1989 issue, I presented the design for a very simple and low cost PC-Driven Function Generator. It was essentially just a DAC (digital to analog converter) in a box, which connected up to a computer's parallel printer port. As a result the DAC could be made to generate an almost infinite variety of waveforms, simply by feeding it a stream of data bytes from the PC. Matching software allowed you to generate sine, square, triangular or sawtooth waveforms, or even to produce arbitrary waveforms of your own.

Because the whole thing was software driven, and also dependant on the rate at which the PC was able to squirt data bytes out of its printer port, the unit was quite limited in terms of the maximum output frequency. Even with an assembly-language output routine, it was only capable of generating signals at frequencies below about 1kHz, when driven from a 12MHz 286-based PC. A faster PC would lift this a little, but not a great deal.

Despite this limitation, though, the project was surprisingly popular. Perhaps this was because many custom and special test signals are only needed at relatively low frequencies. It may also have been because for many people, the unit provided the only affordable way to generate custom waveforms at all.

All the same, in the last year or so I've been getting quite a few requests for an updated version of the design — and one that would hopefully go considerably higher in frequency. It was an interesting challenge, and I set about seeing what could be done.

Fairly clearly, the basic idea of using a DAC fed with a stream of waveform 'samples' was still the right way to go. But the only way to achieve a really worthwhile lift in the maximum output frequency would be to remove the unit's direct dependance on the PC software and printer port, so that the samples could be pumped into the DAC at much higher rates. This implied the addition of local memory, so that a set of waveform samples could be downloaded from the PC, and then 'played back' into the DAC at the desired rate by a local sampling clock...

But how would the local clock be generated, and varied in frequency to control the output frequency of the waveform? One possibility would be to use a DDS (direct digital synthesiser) for the clock, with its output frequency programmed from the PC along with the downloaded waveform. Suitable DDS chips have been readily available for a while, and they're not *too* expensive.

When I explored this idea, though, it soon became clear that the cost and complexity of the generator would rise

rapidly. There *had* to be a simpler and more elegant approach.

A tantalising thought occurred: a DDS is already based on 'replaying' a stored waveform, using a fixed sampling clock frequency. Although a basic DDS can only be used to produce a sinewave, according to theory, mightn't there be some way to adapt the idea for generating *any* desired waveform?

Well, to cut a long story short, I finally managed to come up with a way to do just that. It *is* a kind of 'poor man's DDS' system, based on the same basic idea of playing back a digital waveform 'recording' using a fixed clock frequency. However unlike a DDS it *can* produce virtually any desired waveform.

Of course there are no 'free lunches' in this world, and inevitably there's a price to pay for this added waveform flexibility. In this case the price is that we don't have the same frequency setting resolution as a true DDS, over the full output frequency range. Whereas the output frequency of a DDS can be changed in quite small increments over the entire range, this technique provides similar small increments only at the low end of the range. The increments steadily increase as the frequency increases — becoming quite coarse as you approach the Nyquist limit at half the clock frequency.

Despite this limitation, though, I believe I've still been able to come up with a very practical and useful instrument. The final design presented here can produce signals of virtually any waveform, at frequencies from below 0.25Hz right up to beyond 100kHz and with incremental frequency resolution of 1% or better up to 20kHz. The actual resolution plotted over most of the output frequency range is shown in Fig.1. The 'steps' at 16Hz and 62Hz are due the fact that the final design actually uses three clock frequencies, to cover the full output frequency span.

As with a DDS, the output frequencies are all derived digitally from a crystal-based master clock. So each output frequency is again just as accurate as if it were derived from a crystal — even though in this case there aren't as many possible output frequencies as from a DDS.

As with the simple 1989 generator, most aspects of the new generator's operation are controlled by software running on the PC. So far I've developed basic software to both test the generator hardware and get it to generate a range of standard 'function generator' waveforms.

We also have plans to develop some additional software, to allow you to 'draw' your own custom/arbitrary waveforms in a convenient way. It should also be possible to develop programs which convert waveforms captured with the DSO Adaptor Mk2 (May/June 1994) for downloading to the new generator, and perhaps also to convert digital audio WAV files as well. No promises, but we'll see what we can do.

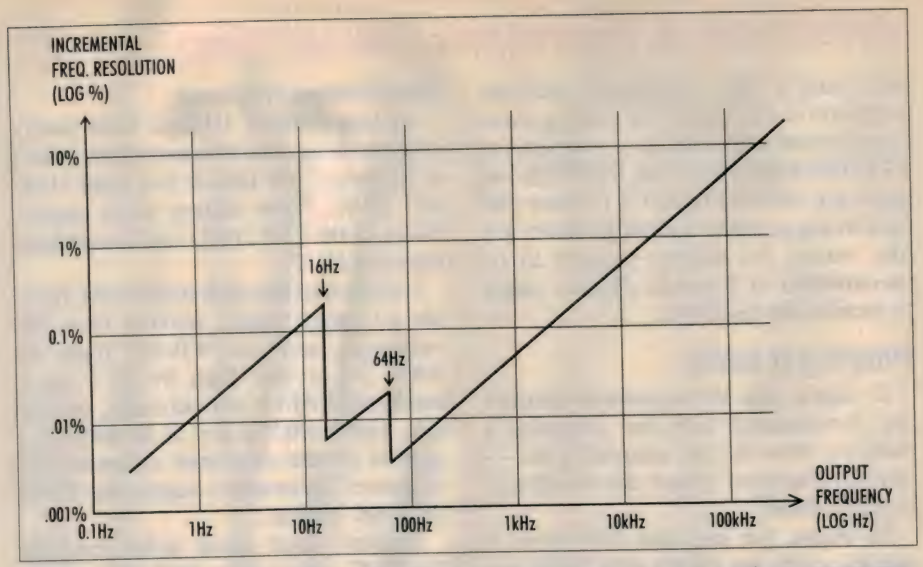


Fig.1: Because of the technique used, the generator's output frequency resolution is quite coarse at frequencies above 100kHz. Below 20kHz, though, it can be changed in steps of less than 1%.

How it works

OK then, let's see how the new generator works. Fig.2 shows the heart of the circuit, and we can use this to visualise exactly how the waveforms are produced.

U3 is the DAC, which converts our 8-bit waveform samples into the raw analog output. We're using here the same TDA8702 video DAC chip that was used in Tibor Bece's YADDS-1 module, as used in the PC Controlled Sweep Analyser (Sept/Oct 1995) and the Audio Sweep Analyser (March/April 1996).

The generator's inbuilt waveform memory is provided by U2, a '32K x 8' 62256-10 static RAM device. This is the same memory chip used in the DSO Adaptor Mk2, and is capable of storing up to 32,768 bytes of waveform samples. Counter chips U4-7 are used as an address counter for the memory chip; we use 74HC161 synchronous counters here, for much faster address setup than could be achieved using 'ripple carry' counters.

U1 is a 74HCT244 octal buffer, used to connect the memory/DAC data lines to the computer's printer port during waveform downloading. However the buffer also allows this connection to be broken, once the waveform samples have been downloaded into U2 and the generator is to be 'run'.

The function of the rest of the circuitry should become clear as we follow through its operation.

We can begin by assuming that the software running in the PC has worked out the sequence of data byte 'samples' necessary to produce one cycle of the desired waveform. We'll see what this involves, and how it's done, later on.

When you instruct the software to begin the downloading sequence, it first manipulates the printer port's control lines to switch the generator to 'RESET' mode. We'll see how this is done shortly, but for the present the main thing to note is that the generator's RESET-bar control line goes low. This causes memory address counters U4-7 to be reset, via gates U10a and U10b.

Then, the software again manipulates the control lines to switch the generator to 'LOAD' mode. This causes the generator's LOAD-bar line to go low, and the LOAD line to go high.

Looking now at buffer U1, the low at the OE-bar pin enables the buffer outputs and hence allows any data fed out on the PC printer port to be fed into the generator's data bus.

Note that the STROBE-bar line from the printer port is connected to the write-enable (WE-bar) input of RAM chip U2, and also inverted to provide a STROBE line, which is fed to one input of gate U10d. The other input of U10d is connected to the LOAD control line, so that in LOAD mode the inverted STROBE-bar pulses are fed via U10d and U10c to the clock lines of U4-7.

As you can seen, this means that the software can 'write' each waveform

data sample into successive memory locations in U2, simply by feeding them to the printer port with an accompanying STROBE-bar pulse. Each STROBE-bar pulse not only instructs U2 to store that byte in the current memory location, but also causes the address counter to be incremented to the next address, ready to receive the next byte.

Playing it back

So that's how the waveform samples are downloaded into the generator's memory. Now for the interesting bit — how the generator 'plays' the waveform, in RUN mode.

To begin, the software first sends a control code to switch the generator from LOAD mode to RESET mode. This disables data buffer U1, and also resets the memory address counters. Then the software sends a further control code, which switches the generator into RUN mode.

In this mode, one of three sampling clock signals is gated onto the RUNCLOCK line, which feeds into input pin 5 of U14b. We'll see how the clock signals are produced shortly; for the present, it's sufficient to note that U14b is now fed with either 2MHz, 250kHz or 7812.5Hz pulses — according to the desired output frequency.

As you can see, U14b is used purely as an inverter. The inverted clock pulses at its output are then fed to both U14c and U10c. These convey them respectively to the DAC (U3) and the address counters U4-7.

Note that in this operating mode, there are no strobe pulses arriving from the computer, and the WE-bar input of RAM U2 is held high by R17. As a result, the RAM is in read mode, and the data byte stored in any of its addresses appears on the data lines automatically whenever the counters supply the RAM with that address.

Similarly each clock pulse reaching the DAC causes it to latch the current data byte into its internal conversion register, and produce the corresponding analog output.

The nett result is that the stream of RUNCLOCK pulses causes each of the stored waveform bytes to be read out of the RAM in turn (starting at address zero), and latched into the DAC for conversion. And this all happens at a rate of either 2MHz, 250kHz or 7812.5Hz, according to the selected clock signal.

So far, it's all just a straightforward system to read our waveform data bytes out of the RAM, and feed them into the DAC. But how do we end up with our desired output frequency? Ah, I wondered when you were going to ask, because that's actually the key to the way this 'poor man's DDS' system works.

Setting the frequency

You'll probably have noticed U9, a 74HC30 octal NAND gate, sitting there innocently with its inputs all connected to the eight data lines. Its output is connected to pin 1 of U10a, so that whenever the output goes low, the counters will be reset. (Since we're no longer in LOAD mode, pin 4 of U10b will now be high, and this gate will allow the reset pulses through.)

Now this means that the address counters will be reset whenever U9 detects an 'all ones' data byte (i.e., FF hex or 255 decimal). For all other combinations of the eight data bits, the output of U9 will remain high and the reading-conversion process can continue without interruption. So what we do is arrange that the PC software deliberately restricts the amplitude range of our waveform samples, to between 00 and FE hex (0 - 254 decimal). Then, at the very end of the waveform 'recording' it downloads into the generator's RAM, it attaches an additional 'end of recording' (EOR) byte. And the value

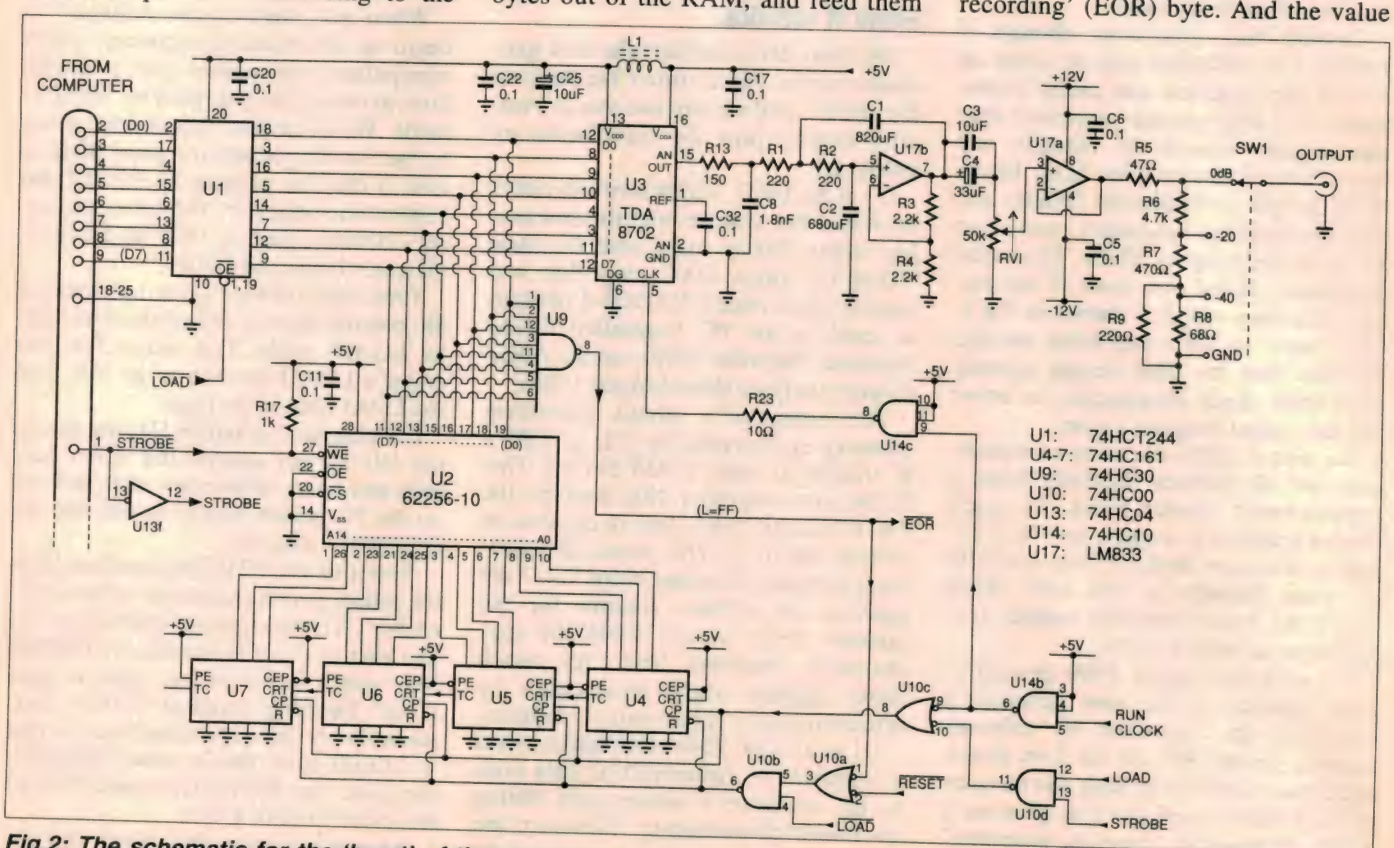


Fig.2: The schematic for the 'heart' of the generator. Waveform files are downloaded from the PC and stored in U2, a 32KB static RAM. They're then 'played' via DAC U3, to produce the waveform.

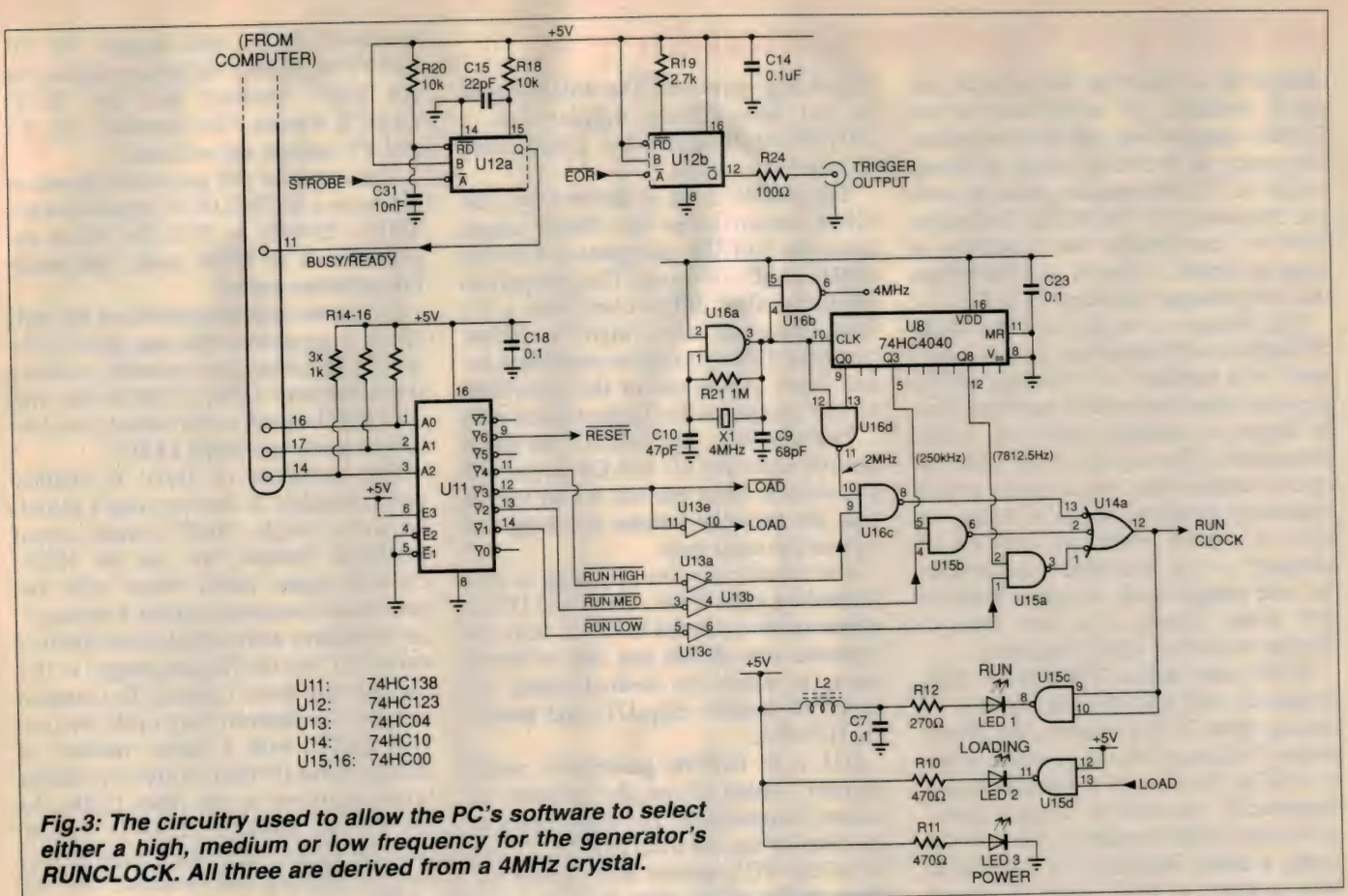


Fig.3: The circuitry used to allow the PC's software to select either a high, medium or low frequency for the generator's RUNCLOCK. All three are derived from a 4MHz crystal.

of this EOR byte is — you guessed it — FF hex (255 decimal).

As a result, as soon as this EOR byte is read out, each time the end of that waveform recording is reached, the output of U9 goes low and the counters are immediately reset. This means that the waveform 'replay' process switches back to the start of the recording again.

Doesn't the EOR byte, with its value of 'FF', cause a brief glitch in the DAC output? No, because the circuit is arranged so that even at the 2MHz clock rate, the address resetting and readout of the data byte in the RAM's starting address all takes place *before* the end of the current clock pulse. Which means that when the DAC latches in its next data byte, it's the byte in address zero. So the DAC never actually 'sees' the FF byte; it's used purely to reset the counters to the RAM's starting address, at the end of the current waveform 'recording'.

It's this technique of making the RAM address counter automatically reset at the end of the waveform record, whatever its length, that allows us to generate signals of many different frequencies, from only three sampling clock frequencies. We do this by having the software calculate in advance the correct number of samples, at the appropriate clock rate, to produce one cycle of the desired output frequency. Then by downloading just this number of samples, with values calculated to produce the desired waveform, we arrange for the generator to produce not only the desired waveform, but the correct frequency as well.

Some examples

An example or two should make this clear. Let's say we want to produce a signal at a frequency of 50kHz. This means that one cycle of the output frequency will need to be 1/50,000 of a second, or 20 microseconds long. We can achieve this very easily using the 2MHz clock (i.e., a clock period of 0.5us), by downloading a waveform file 40 samples long (40 x 0.5us = 20us). So all our software has to do is work out the correct values for those 40 samples, to produce a single period of the desired waveform — sinewave, squarewave, triangle, sawtooth or whatever. Then it adds an 'FF' byte to the end, and downloads it to the generator. When the generator runs, it then produces a 50kHz signal of the correct waveform.

Similarly to generate a signal at 100Hz (i.e., with a period of 10ms), we can again use the 2MHz clock, but this time make our waveform record 20,000 samples long (20,000 x 0.5us = 100ms). Again all our software has to do is calculate the correct values for those 20,000 samples, to produce the desired waveform, and then download them with an 'FF' byte added to the end.

Get the idea? We rely on the software working out (a) how many samples of the most appropriate clock signal will be needed to achieve one cycle of the desired output frequency, and then (b) the values of each of those samples to produce the desired waveform.

Perhaps now you can also see why this system becomes limited in its frequency resolution, at the higher frequencies. It's because a waveform 'record' can only have a length corresponding to an integral number of samples — and with increasing frequency, the frequency increment corresponding to a change in record length of one sample becomes larger.

For example to produce an output signal of 100kHz with our 2MHz clock, we need only 20 samples. But our next available higher output frequency is 105.263kHz (i.e., a 19-sample record), and our next available lower frequency is 95.238kHz (with a 21-sample record).

In contrast, down at the 100Hz level our waveform record is much longer, using the same 2MHz clock, and the frequency increments corresponding to a

change up or down by one sample are much smaller. A waveform record 20,001 samples long will give an output frequency of 99.995Hz, while a record length of 19,999 samples gives an output frequency of 100.005Hz. So at this level we can change the frequency in steps of 5mHz, whereas at 100kHz we can only change it in steps of 5kHz.

This brings us to the need for three different clock frequencies in our generator. In a nutshell, it's because of the way our waveform record must increase in length, to achieve lower and lower frequencies. For a given clock frequency and memory size, reducing the output frequency therefore brings us sooner or later to a point where we 'run out of memory' — i.e., the number of samples for one output cycle is larger than we can store. Clearly it's then time to change to a lower clock frequency...

In this case, with a 2MHz main clock frequency and a RAM chip capable of storing up to 32,768 samples, the lowest output frequency we can generate is just over 61Hz. So in order to generate lower frequencies, we need to 'change down' to a lower clock frequency. Here we're using a clock frequency of 250kHz to take us down to 16Hz; then we change down again to a clock of 7812.5Hz, to allow us to generate frequencies down to just below 0.24Hz.

Clock selection

The different clock frequencies are selected automatically by the software, and the circuitry used to achieve this is shown in Fig.3.

The signals are all derived from a 4MHz crystal oscillator, using gate U16a and crystal X1. Gate U16b provides a buffered version of this signal for testing purposes. The 4MHz signal is fed into binary divider U8, a 74HC4040, to derive the actual clock frequencies we use.

The 2MHz clock is derived by gate U16d, which takes the 2MHz output from pin 9 of U8, and gates it with the 4MHz oscillator signal. The gating is to produce a final 2MHz clock with a 3:1 mark-space ratio (i.e., 'high' for 375ns, 'low' for 125ns), to allow more time for our 'reset at the end of the waveform record' system at this highest clock rate.

The other two clock signals are taken directly from the Q3 and Q8 outputs of U8, as their clock periods are far longer than the memory counter resetting and memory re-read time.

The actual selection of clocks is performed by gates U16c, U15b and U15a, whose outputs are fed to U14a. And the software can enable any one of these gates, to select the desired clock, by means of decoder chip U11 and inverters U13a/b/c.

U11 is in fact the generator's mode decoder, which allows the software to control its operation. The three inputs to the decoder are fed from pins 16, 17 and 14 of the PC's printer port. These are three of the printer port 'handshaking' lines, normally used to control special printer functions: 'initialise', 'select' and 'auto linefeed'. For our purposes here, the main thing is that the lines can be manipulated easily by the software, independently from the data lines.

So by manipulating these three control lines, the software can determine which of decoder U11's eight active-low outputs is low at any time. Here we use output Y6 to produce our RESET-bar control signal, output Y3 to produce our LOAD-bar signal (inverted by U13e to produce LOAD), and outputs Y4, Y2 and Y1 to produce the gating signals for our 'high', 'medium' and 'low' RUNCLOCK signals. The decoder's Y0, Y5 and Y7 outputs are not used.

The output of OR gate U14a therefore produces a RUNCLOCK signal of either 2MHz, 250kHz or 7812.5Hz when the generator is in RUN mode, and under full software control.

So that the operating mode of the generator is apparent to the user, gates U15c and U15d are used as inverters, to drive some indicator LEDs. U15d is fed with the LOAD signal, so its output goes low in that mode and lights LED2.

The operation of U15c is slightly more complex, as here we don't actually have a single 'RUN' control signal available. Instead, we use the RUNCLOCK signal itself, which when the generator is running, carries a rectangular waveform with a mark-space ratio of either 3:1 (on the highest range) or 1:1 (on the two lower ranges). To compensate for this reduced duty cycle we provide LED1 with a series resistor of smaller value (270Ω), to give it a similar brightness level to the other LEDs. As the current through LED1 is pulsed, inductor L2 and capacitor C7 are used to provide filtering and minimise the risk of RF radiation.

LED3 is used purely for power indication, and is simply fed from the +5V rail via R11. (Note that there is no LED indicator corresponding to the RESET mode — this is basically the generator's default mode, corresponding to it being in neither LOAD nor RUN modes.)

While we're looking at Fig.3, the circuitry around U12a is used to derive a BUSY/READY-bar signal from the incoming STROBE-bar signals, to ensure that the PC software can't download data faster than the generator can 'digest it'. Resistor R18 and capacitor C15 give a delay time of about 350ns, which is sufficient to give the circuitry of Fig.2 time to write each data byte into the RAM.

U12b, the other half of a 74HC123 dual one-shot, is used to derive a scope trigger output from the EOR-bar signal produced by U9, in Fig.2. In this case resistor R19 is used alone, without a capacitor, so that U12b produces a negative-going pulse around 300ns wide, each time the generator's waveform replay circuitry resets to begin a new cycle in RUN mode.

Output circuitry

Returning now to Fig.2, the circuitry around U17a and U17b is used to provide filtering and buffering for the analog output signals produced by the DAC. The fil-

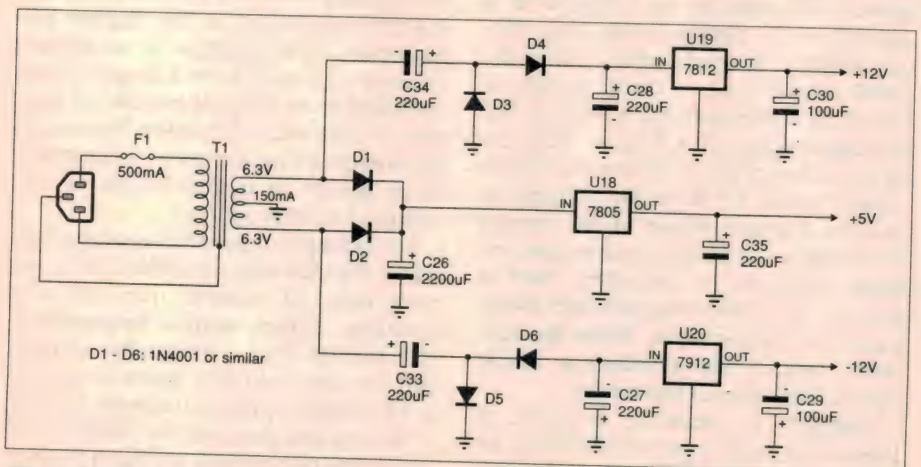


Fig.4: Most of the generator's circuitry is digital and operates from the +5V supply. Only the analog output circuitry operates from the +/-12V rails.

tering is performed by U17b, connected as a three-pole active low pass filter, with a nominal Butterworth characteristic. The corner frequency is at just under 700kHz, which gives reasonably good rejection of the 2MHz clock and glitches in the DAC output, while still passing enough harmonic content to give quite reasonable output of 'complex' waveforms at frequencies up to beyond 100kHz.

As the output from the DAC has a significant DC component, this also appears at the output of U17b. To remove this DC from the generator output, we use coupling capacitor C4 with parallel component C3 to ensure a low impedance at high frequencies. The LF corner frequency provided by C4 and level control RV1 is at around 0.1Hz, giving very little attenuation even at the generator's lowest output frequency of 0.24Hz.

U17a is used in voltage-follower mode as an output buffer, followed by a switched attenuator to control the output level in conjunction with RV1. SW1 allows reduction of the output in two 20dB steps, and also provides a 'GND' or zero output position. The generator output impedance is less than 500Ω at all settings of the attenuator.

Power supply

The remaining section of the generator's circuitry to be discussed is the power supply, which shown in Fig.4. As you can see this is quite straightforward, and all based on a low cost and readily available centre-tapped 12.6V/150mA transformer.

Diodes D1 and D2 form a conventional fullwave rectifier feeding reservoir capacitor C26, with regulator U18 used to provide a +5V rail to power virtually all of the generator's digital circuitry. The remaining components are used to provide the +12V and -12V rails needed by analog output device U17.

As the latter rails only need to provide about 8-10mA, halfwave voltage doubling rectifiers are used to provide the unregulated DC for them. D3, D4 and C34/C28 are used to produce about +16.5V for positive regulator U19, while D5, D6 and C23/C27 perform the corresponding functions for U20 and the negative rail.

Note that for safety, the frame and core of power transformer T1 are connected to mains earth. However the earthy side of the generator's signal circuitry is left floating — apart from being connected back to the earth of the PC, via the cable to the printer port.

That concludes this first article describing our new PC-Driven Arbitrary/Function Generator. In the second article we'll describe its construction, testing and use.

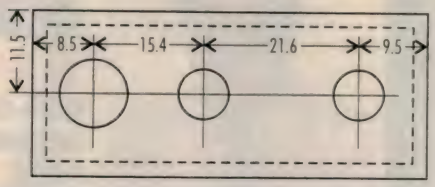
(To be continued.) ❖

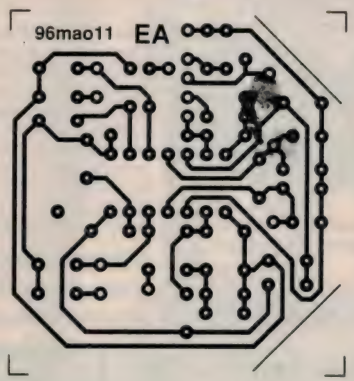
Mini Oscillator

Continued from page 67

Here is the artwork for the Miniosc PCB and front panel, reproduced actual size for those who like to make their own.

Fig.4 (below): The positions and sizes of the holes that need to be cut in the front panel, for the pots and BNC connector.





The square wave function can be used in conjunction with a CRO to examine transient responses for ringing — or more likely when testing by ear, when checking out signal processors and effects units like delay and reverberation, whether mechanical or electronic. You need an input signal rich in harmonics for the full sound of these units to be heard. A square wave signal contains all the odd numbered harmonics of a frequency, diminishing in relative intensity, out to beyond audibility.

Sweeping the square wave back and forth over one or two octaves will further enhance the audibility of effects, not to mention creating some wonderful sci-fi type noises.

Output leads

A variety of output leads or adaptions may be needed. I use a BNC to stereo jack (6.35mm) lead, with an adaptor to RCA plug when necessary. Lead adaptors to XLR (Cannon) plugs may also be made for use with professional type audio equipment. In most cases pins 1 and 2 should be linked on the 'Cannon' to connect Miniosc to the input, or else connect Miniosc between pins 2 and 3 for floating balanced (transformer) inputs.

Modifications

Some modifications are possible to the Miniosc circuit as it stands and there may be others you can develop:

1. The frequency limits can be altered by changing the values of capacitors C1, C2, C5 and C6. Increasing C5 and C6 for example to a value of 0.15uF extends the range down to 20Hz. Some other values (R8 and R9) will need altering also to prevent a gap occurring in the frequency coverage.
2. The range of the sweep control can be increased or reduced by changing the value of the end resistors R8 and R9. However, do not go below a value of 680 ohms.
3. The output level control/power switch can be changed to a 1kΩ type if operation into low impedances needs to be optimised. This will make level setting more progressive than with the 5kΩ pot specified when feeding low impedance loads. (This will increase the sine wave battery load to 2.2mA, while the square wave load remains at 4.7mA.)

And finally, a few notes:

1. The output frequency is given by $f = 1/(2.\pi.R.C)$, where R equals the resistance to ground from pins 3 and 12 of the TL064 and C equals the total capacitance feeding R in each case.
2. The sine output level is unaffected by battery voltage variations, provided the 6.3 volt minimum is available.
3. Temperature affects slightly the output level, due to the effect on the diodes. An increase in temperature will cause the output to fall by approximately 0.4% per degree. ❖

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Jack O'Donnell

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Transmit video and stereo audio over twisted pair cable! Ideal for security cameras, video networks, intercoms etc

K 5860 Video Transmitter & Receiver **$49**

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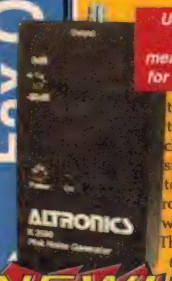
Pink Noise Generator Kit



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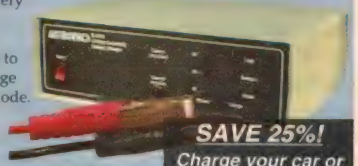

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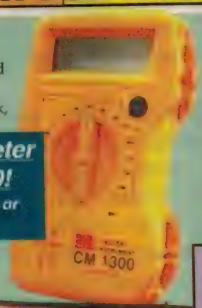
Pocket Digital Multimeter



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Mini Construction Project:

EASY TO BUILD SMT BABY MINDER

Here's a low cost, easy to build project that will give you valuable 'hands on' experience in surface-mount technology, as well as providing you with a useful end product. It's a very low power 'FM wireless microphone', suitable for monitoring sleeping infants and people confined to bed, using any standard FM radio.

The idea behind this little project was not so much to produce an FM wireless microphone, but to provide an interesting and worthwhile exercise in electronic construction using surface-mount components. Many TAFE colleges have been looking for such projects, to give their students practical experience in handling SMD components. This type of project needs to involve a relatively small number of components, to keep the cost down and make it feasible for students to complete its assembly in the allocated class time, while at the same time resulting in the production of an end-product that is interesting and useful.

This project seems to meet these requirements quite well. It involves only two transistors and a handful of low-cost parts, on a PC board measuring only 33 x 15mm. Despite this, it includes enough surface-mount components to provide worthwhile experience in SMD assembly, while not too daunting or time consuming.

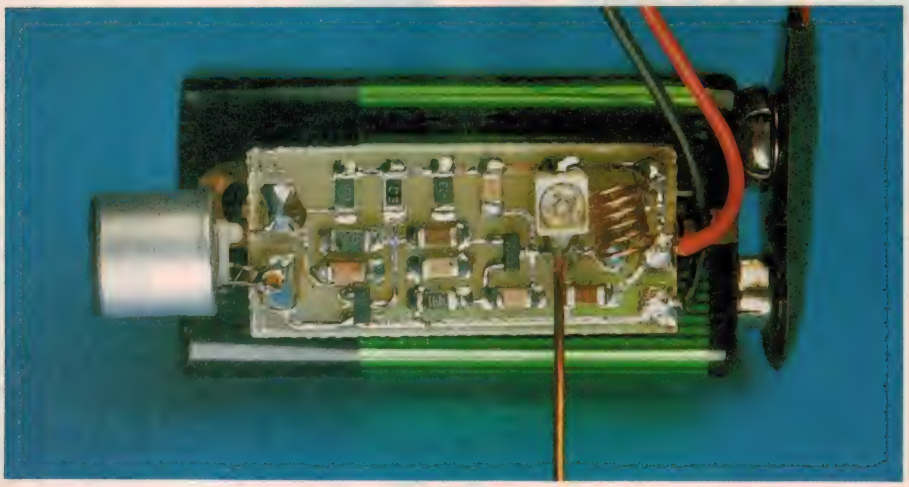
It's almost a bonus that in this case the project also happens to result in an FM wireless microphone whose output can be picked up with any standard FM radio, and is very suitable for monitoring a sleeping baby or sick room.

How it works

As you can see from the schematic, the circuit is fairly conventional and consists of two stages: an audio amplifier and an RF oscillator.

The electret microphone used to pick up the sounds is a standard type containing an inbuilt FET preamp transistor. This is biased by 47k resistor R1. The audio signal generated by the mic is then passed through 22nF coupling capacitor C1 to the BC847 audio transistor, which is wired as a self-biasing common emitter amplifier stage. This is used to boost the signal output from the microphone to a level suitable for driving the next stage. Resistor R2 (1M) provides the bias, and the stage has a gain of about 60-80.

The amplified audio is then fed through 0.1uF coupling capacitor C2 to the base of the oscillator stage. This stage uses a BF599 RF transistor, which is designed to operate at high frequencies. It is connected here in the Colpitts oscillator configuration.



Use this closeup of the PCB as a guide, along with the overlay diagram, when you're wiring up your own minder board.

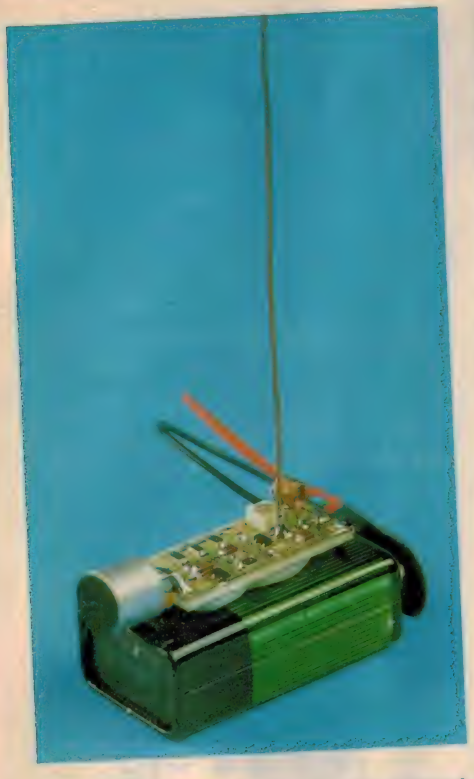
Bias for the transistor is provided by 47k resistor R4, with stabilising current feedback from the 470Ω emitter resistor R5. Capacitor C3 (1nF) holds the transistor's base at ground potential for RF signals, while allowing the audio signals to pass unimpeded. The oscillator 'tank' circuit is provided by five-turn coil L1 together with its parallel capacitance, formed mainly by the combination of 2-10pF trimmer CV1 and fixed 10pF capacitor C5. However the second 10pF capacitor C4, between collector and emitter, together with the transistor's emitter-base capacitance, also help determine the operating frequency — as well as providing the feedback necessary for oscillation.

The component values shown are important as they determine the circuit's oscillation frequency. The values were chosen so the unit would work at around 100 - 108MHz, so that its output can be picked up using a standard FM radio.

Capacitor C6 (22nF) across the battery holds the +9V rail at ground (i.e., negative rail) potential for AC, and hence ensures that the circuit operates stably even when the battery is nearing the end of its life.

By feeding the oscillator transistor's base with audio from the amplifier stage, the audio signals become superimposed on the transistor's bias, and effectively modulate its base-emitter junction capacitance. This in turn causes the desired frequency modulation (FM) of the oscillator.

Note that the unit's antenna is merely a short length of tinned copper wire, connected to the collector of the oscillator transistor. For best results the wire should be cut to correspond to a sub-multiple of the oscillator's wavelength, allowing for end effect, etc. Suggested lengths are 18.6cm, 42cm, 83cm or 156cm, and you may want to experiment to get the best radiation pattern and efficiency for a particular unit and application.



As well as providing valuable experience in handling SMT components, the project also results in a handy wireless microphone.

Construction

Construction of the unit is quite straightforward, as everything is mounted on the printed circuit board.

Firstly, check that you have all the components and correct tools. For assembly use tweezers to place the SM components, and use very thin resin-cored solder with a small fine-point soldering iron.

Stick the PC board to your work area with 'Blu Tack', copper side up, so it cannot move while you solder the components to it. Then lightly tin one of the PCB pads (the right-hand side if you are right handed) for a resistor — say R1 (47k). Then identify the component (the body markings are shown in the parts list), pick it up with the tweezers move it into position. You can now touch the pad and resistor end with the tip of the soldering iron until the solder has flowed and the join has fused together. As soon as the joint cools this will hold the component to the PCB. **Do not apply the soldering iron to the pad or component for TOO LONG, or one or the other will be damaged.**

Continue to mount the resistors one by one, and by one end only, using this method. Once the resistors have been mounted you can mount the capacitors in the same way. Be particularly careful with these as it's easy to mix them up — they're not coded the way the resistors are.

Once all of these passive components have been mounted you can spin the board around and solder the other ends of the resistors and capacitors. At this point check that all components have been mounted correctly.

Next solder one side of the pads where the trimmer is to be placed, and also one side of the trimmer itself. Then place the trimmer into position and solder the pad and trimmer together. Turn the board around and solder the other side.

By now you will have some experience in soldering surface-mount components. If you thought the resistors were hard, wait until you solder the transistors! These are next, in fact.

I suggest you mount transistor Q1 first, followed by Q2. Note that Q1 will have '1H' printed on it, while Q2 will have 'NB' on it. It's very important not to mix the two transistors up, needless to say.

To mount each transistor, first use a tiny amount of solder to tin the PCB pad which will mate with its collector tab (the single tab on one side). Then slide the transistor over the three pads with the correct orientation, and quickly solder the collector tab to its pad, in the same way as you started with each resistor. Then turn the board around and solder the base and emitter tabs to their PCB pads.

Once these components are soldered into place, the rest is easy. Mount and solder the microphone to the PC board. Note that one lead has red insulation and the other has black; the red is the 'live' lead, going to R1 and C1, while the black lead is the one connecting to the negative rail. I cut my leads down to around 5mm long, to keep the microphone body close to the board.

Next we have to make the coil. Using 0.5mm enamelled copper wire, wind five turns around a 3mm shaft such as a small Phillips screwdriver, or the shank of a 3mm twist drill, and cut the excess off. While holding the coil on the screwdriver or drill, you can scrape the enamel off about 2mm at each end and tin them with solder. Then solder the coil to the board. Note that the coil sits above the 10pF capacitor C5 alongside the trimmer, as in the overlay diagram.

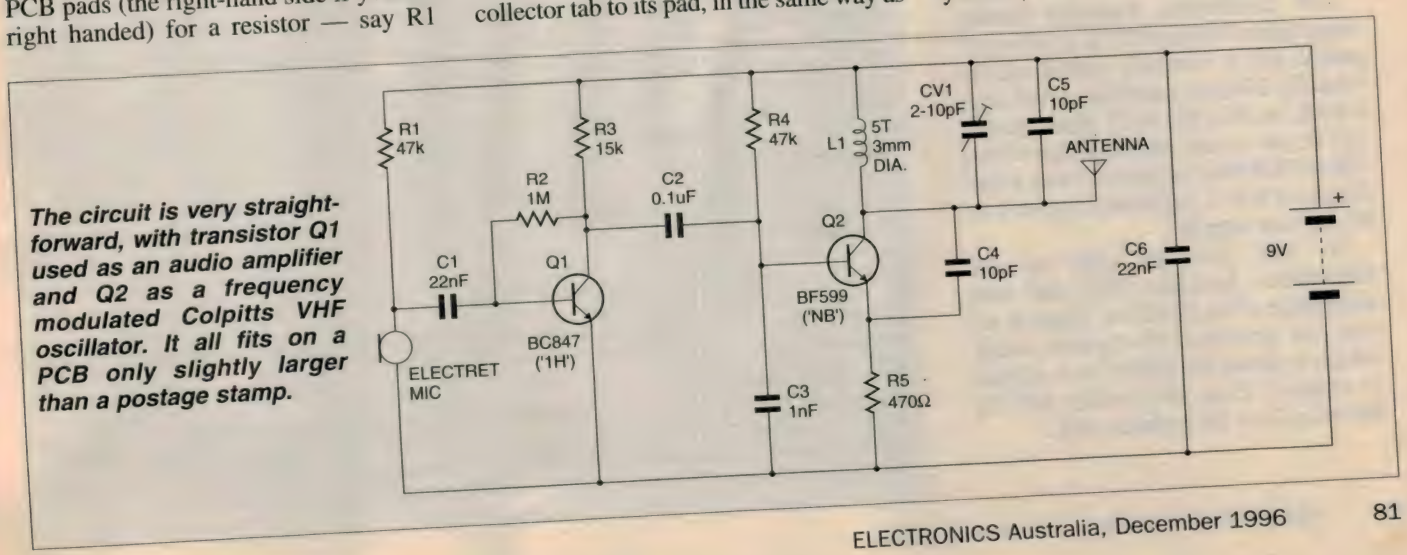
Now solder the aerial wire to the pad just next to the trimmer capacitor, alongside the collector of Q2. Also solder the battery snap leads to the board, making sure the leads are the correct way around — the black lead connects to the pad in the corner, and the red to the pad which runs up to the coil, 10pF capacitor and trimmer.

Next use a small amount of Blu Tack or double sided tape to mount the board onto the battery. This helps to give the transmitter a ground plane and improves its performance.

Setting it up

You will need an FM radio to adjust the oscillator tuning. We do not recommend a digital type, but one with an analog dial so you can tune in more easily.

Turn on the radio and tune it up the FM band to around 106MHz, or wherever it's clear of stations. Turn the volume up until you hear the hiss in the background. Now



The circuit is very straightforward, with transistor Q1 used as an audio amplifier and Q2 as a frequency modulated Colpitts VHF oscillator. It all fits on a PCB only slightly larger than a postage stamp.

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So feel free to call up the Electronics Australia BBS, and take advantage of its facilities. There is no cost for accessing the system itself, which is provided purely as a service to readers. Your only outlay will be the usual cost for a phone call...

SMT Baby Minder

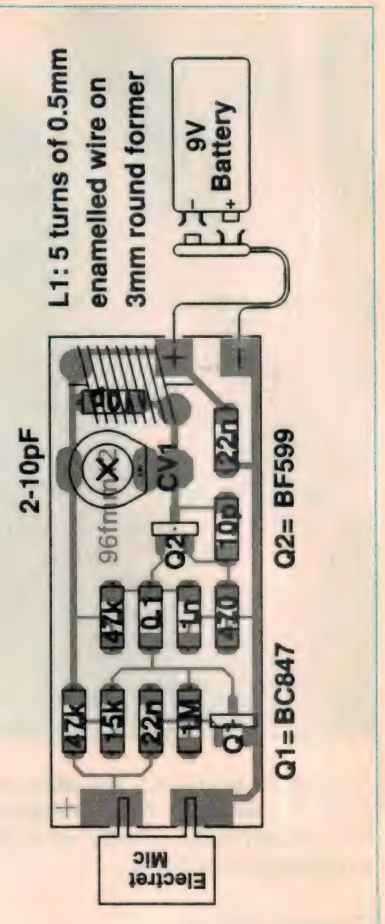
plug in the Baby Minder's battery and sit it near the radio. Gently move the turns of the oscillator coil together or apart until you hear the whistle from the radio. Once this is done you can adjust the trimmer to fine tune it — but remember this is still very touchy so some experimenting will have to be done.

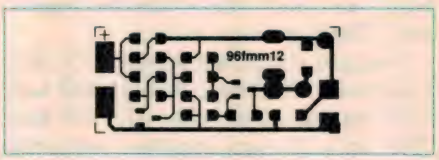
The minimum useful length of the antenna wire is about 185mm, but you may wish to experiment with longer lengths — say 660mm or 850mm — in order to get a longer range.

The circuit has been designed to sit in one spot, as moving it around or touching it will disturb its operation.

If you want to make the Baby Minder work at lower frequencies, say 100MHz, you can push the windings of the coil closer together and adjust the trimmer accordingly. After you have set it where you want, it is a good idea to get a small candle and melt a couple of drops of wax onto the coil to hold the coil in the correct position.

After you've built this little project you'll have a much better feel for the way surface-mount components are used. You'll also have a handy little FM microphone for monitoring the baby! ❖





Above is the PCB overlay diagram, to guide you in building the project. At left is the PCB pattern itself, reproduced actual size for those who wish to etch their own.

BABY MINDER PARTS LIST

Resistors

R1,R4	47k ('473')
R2	1M ('105')
R3	15k ('153')
R5	470 ohms ('471')

Capacitors

C1,C6	22nF
C2	0.1uF
C3	1nF
C4,C5	10pF
CV1	2 - 10pF trimmer

Semiconductors

Q1	BC847, SOT23 pkg ('1H')
Q2	BF599, SOT23 pkg ('NB')

Miscellaneous

Mic	Electret insert
PCB	PC board, 33 x 15mm (RCS 4359s)
B1	9V battery with clip lead

Length of 1.2mm diam. tinned copper wire, 185mm long, for antenna; short length of 0.5mm enamelled copper wire, to wind five turns on a 3mm former for coil L1.

KIT AVAILABLE

Kits of parts for this project are available from Laser Installations, of PO Box 13, Little Bay 2036. The price for a kit is only $10, plus $2 for packing and postage within Australia. Payment should be by cheque or money order; credit cards cannot be accepted. Kit enquiries may also be made by phone, on (02) 93111500, or fax on (02) 93111400.

Experimenting with Electronics

by DARREN YATES, B.Sc.

Exploring CMOS circuits — 3

This month, we continue with our look at basic CMOS gate circuits, expanding on some of the ideas we picked up last time. We also discuss some of the practical limitations when you are designing CMOS circuits.

A number of the circuits we looked at last time could have been labelled transistor-replacement circuits or 'plug-ins'. So those of you who may have thought I was running out of circuit designs, let me allay those fears; there is some method in my madness.

Many logic circuits we see today are straight re-designs from transistor circuits that were built many years ago. So if you find a transistor circuit that performed some groovy logic function way back in the 1960s, chances are you can redesign the circuit to use CMOS instead.

The one thing that CMOS gates are better at doing is performing control functions, especially those with more than one input.

This month, our circuits explore the idea of control theory in a more practical way.

A lot of theories are not all that practical in real world situations. Take the theory of relativity, which says that if a bus is travelling forward at the speed of light and you walk from the back of the bus to the front of the bus, then you're moving faster than the speed of light — only you can't! That's all fine and dandy, but from where I stand in Sydney it takes 40 minutes for the bus to get me from my place to Chatswood Station...

Circuits, please...

This month, we're going to start off with a bit of a noise-maker. I designed this twin-tone oscillator sometime back to work in a model fire engine. Whatever you do, if you decide to build this circuit up, don't let your kids near it. There are two things in life that kids like, and that's things that light up and things that make noise. Give them control of the device that makes that noise and they have what seems like ultimate power. (I know, because I can still remember when I used to drive my parents bonkers...)

Rather than give the kids something to play, the circuit in Fig.1 shows us how we can create a controlled twin-tone oscillator with one IC package — namely a 4093 quad two-input Schmitt trigger NAND gate IC.

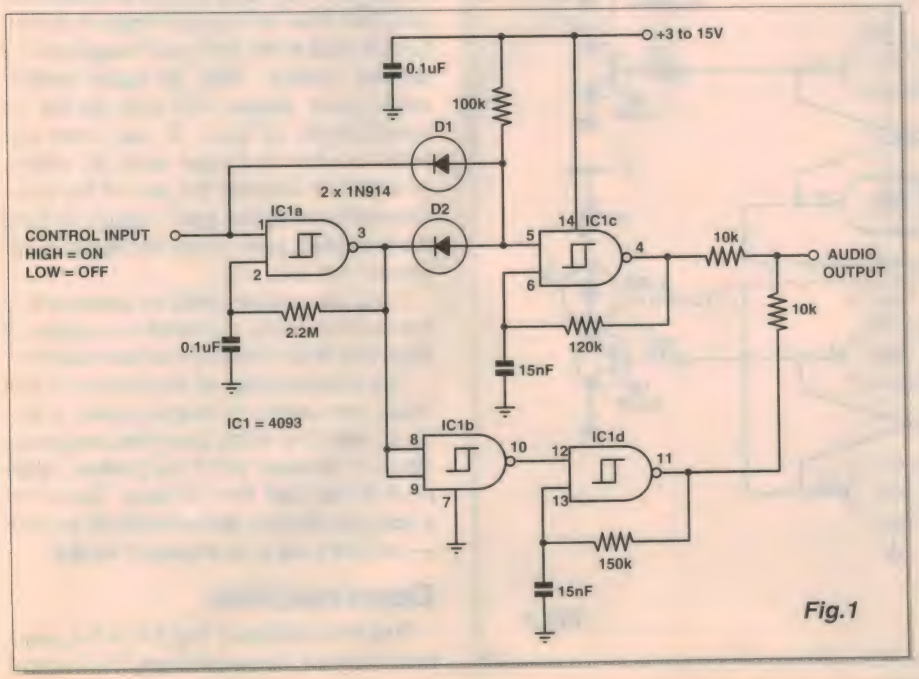


Fig.1

For starters, if you look closely, you'll see I've cheated and that there is actually a fifth gate in there. See it? It's the two diodes D1 and D2. They form a very easy to build AND gate, and they're much cheaper than adding in a second IC.

Looking at the circuit, the input at pin 1 of IC1a is our main control input. It's pretty simple: a high input here allows the noise to be produced, while a low stops it again. Thanks to the Schmitt trigger operation, these gates can form very handy single gate oscillators; all you need is a capacitor and a resistor. You'll notice that three of the four gates in IC1 are connected up as oscillators.

IC1a does double duty, performing the basic control function but also as the main control oscillator, which sets how quickly the circuit warbles from one tone to the next and back again.

The output from IC1a is fed in two directions, firstly to one of the inputs of our diode AND gate and the other to IC1b which forms an inverter. The AND gate acts as a second control gate which is also connected to the main control input.

When the control input goes high, it allows IC1a to oscillate and it pulls diode D1 out of action, allowing the input of IC1c to be controlled simply by the output of IC1a and the diode input. This works quite simply so that when the output of IC1a is high, the diode is reverse biased and the input at pin 12 of IC1c sees a high via the 100KΩ resistor. When the output of IC1a is low, the diode is forward biased and there's only around 0.6V at the input of IC1c, which interprets it as a low.

The 'other half' of IC1c forms another oscillator, this time one of our main audio tone oscillators. Again, when the input from the diode AND gate is high, the oscillator starts cranking. When the gate

input is low, it takes a breather.

Note that this first tone oscillator works when the output of IC1a is high. In order for us to hear two tones we need to turn a second oscillator on when the first is off — i.e., we need alternately-operating oscillators (try and say *that* fast!).

That's where IC1b comes in. As an inverter we can use the dead time in the operation of the first oscillator to get the second one on-line. IC1b simply inverts the timing/gating signal and drives the second of the audio tone oscillators, IC1d.

The outputs of IC1c and IC1d are alternately on and off. Mixing the two tones together is as simple as tying a couple of 10kΩ resistors together, as you can see. The output can then be taken to just about any audio amplifier you can lay your hands on.

Glad we went over the basics of CMOS a couple of months ago, now? This is where that basic understanding pays off. Even designing something as relatively simple as this requires you to be able to juggle some binary maths around in your head, or at least on paper so that you know what's going to happen when. One of the better ways to see how this circuit works is to draw out each waveform on a time line underneath each other, as you see in some logic books.

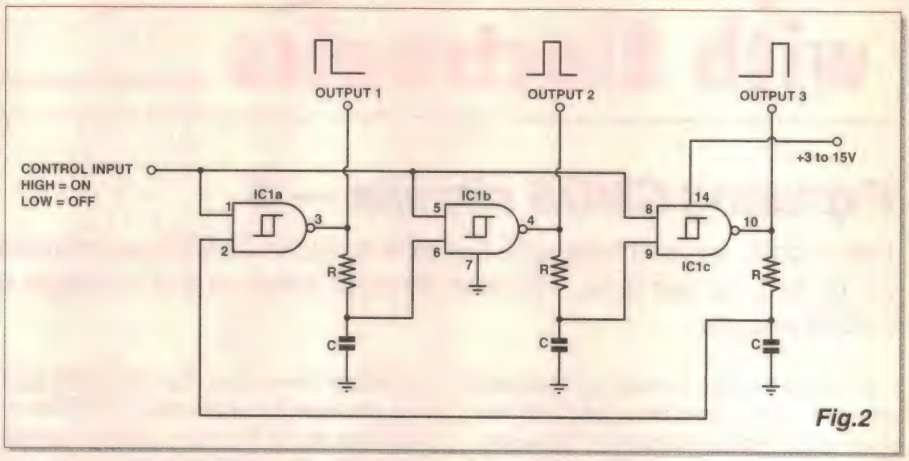


Fig.2

Ring of three?

This next circuit is again a little unusual and takes the 'control' idea another step. In Fig.1 we looked at our control input producing a signal control output — i.e., the output from IC1a. In this circuit, in Fig.2, we use one control input to create a 'walking ring of three' output. Now what's that mean, I can hear you think.

In its essence, it basically means that when the control input goes high, each of the three outputs goes high, one at a time for a period. If we labelled the outputs A, B and C, the result would be ABCABCABCABC etc. Another name for this type of circuit is a *ring counter* — 'ring' because it runs around in a ring, and 'counter' because it actually counts to three.

Counters are a very important part of CMOS circuitry and are often used in digital clocks, alarm circuitry and electronic scoreboards.

Looking at Fig.2, we have used another 4093 CMOS IC. These ICs are very handy because they can be made to work double time — but they're more expensive than an ordinary 4011 IC so you'll need to consider your options.

Notice that each gate's output is connected to a resistor which charges and discharges the capacitor for the next gate. What we really have is three oscillators in one. See how the last gate output is connected back to the first gate's capacitor by another resistor. With all equal components, each output will stay on for an equal length of time. If you want one input to stay on longer than the others, you need to increase the size of the resistor connected to that gate's capacitor from the preceding gate. (Who said digital electronics was easy...?)

Each gate output could be connected to a transistor driver, to switch on a series of three LEDs that light up one after another.

The disadvantage of this circuit is that when you stop it, it forgets where it was up to and just starts from the beginning again — because all of the control inputs need to be tied low at once. However, when you *do* that, the outputs all go high — so don't use it as an on/off switch.

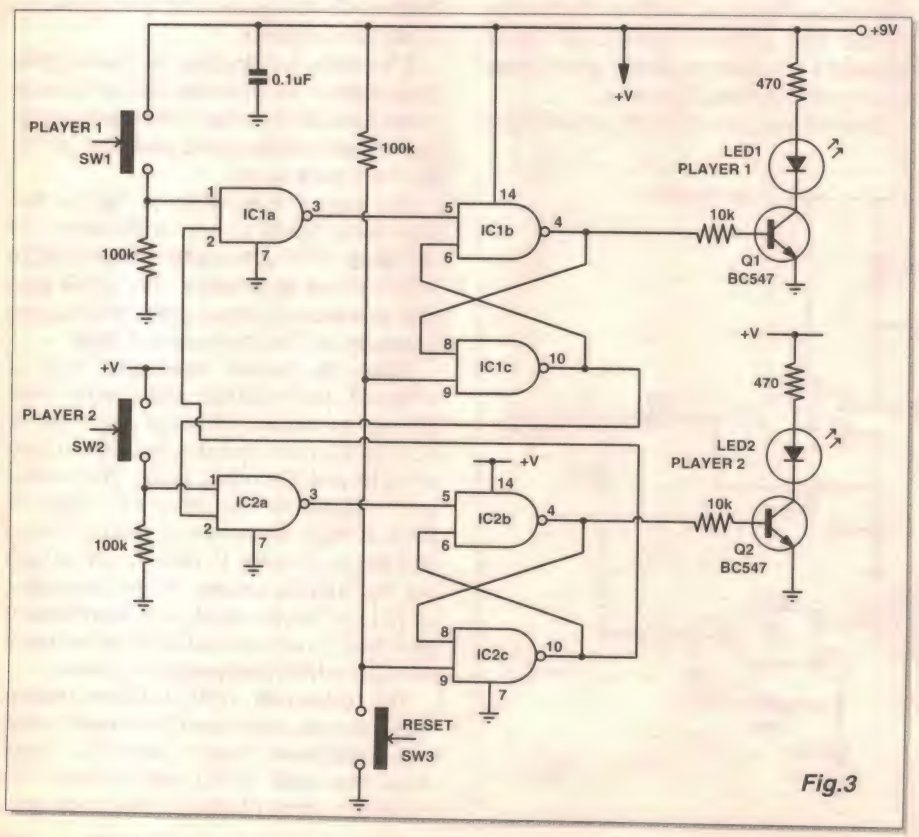


Fig.3

Game machine

Our next circuit in Fig.3 is a fun practical way of demonstrating the control

ability of CMOS gates. I'd be surprised if there was someone who hasn't seen at least one episode of 'Sale of the Century'. How do they ensure who was the first to press down their buzzer button? Do they use the circuit we're about to describe here?

Well... probably not, but this circuit will give you a few hours of fun and help explain some more CMOS theory. It combines both our control theory with the flip flops circuitry that we looked at for the first time last issue.

Before we launch into it, let's first consider what this circuit has to do: it must ensure that whoever is first to press their button not only lights up the corresponding light, but locks out all other buttons as well. A tall order? Well, not really. In fact, we can do the job for two buttons with just two ICs.

Looking at the circuit in Fig.3, if you look carefully you'll see that we have two identical sections which are cross-coupled.

To make it easier to see, each section uses a different IC package. The first section is built around IC1 and the second around IC2. Looking at the section involving IC1 to start with, this circuit fragment is what you could loosely call a *clocked RS flipflop*. Whereas a normal RS flipflop has two inputs which are simply SET and RESET, this flipflop also has a control input.

The common RS flipflop you can see is formed around IC1b and IC1c. But notice that the normal SET input to IC1b pin 5 is connected to the output of another NAND gate. What this NAND gate does is to allow us to control when pulses from switch SW1 reach the SET input. Remember that a NAND gate acts as an inverter when one input is held high, but produces a constant high when one input is held low.

When the circuit is first switched on and the RESET button is pressed, the outputs of both IC1c and IC2c are held high. Notice too that these outputs are connected to the control inputs of the opposite flipflop. Remember too that when these outputs are high, the corresponding outputs of IC1b and IC2b are low, so no lights are lit — which is as it should be, since no one has pressed a button yet. It would be a worry otherwise!

OK. Let's say the compere asks the question, "What's the name of Stinky Murphy's racing pig, Spit?" You've now got two contestants fighting the laws of physics and commonsense to get their hand on their button first. Let's say the bloke on button 1 (SW1) presses his first. He sends a high pulse to the other input of IC1a. Since both inputs are high, the output of IC1a pulls low. This triggers the IC1b/IC1c flipflop into action; the output of IC1b goes high, lighting up LED1 via transistor Q1, to indicate that he hit the buzzer.

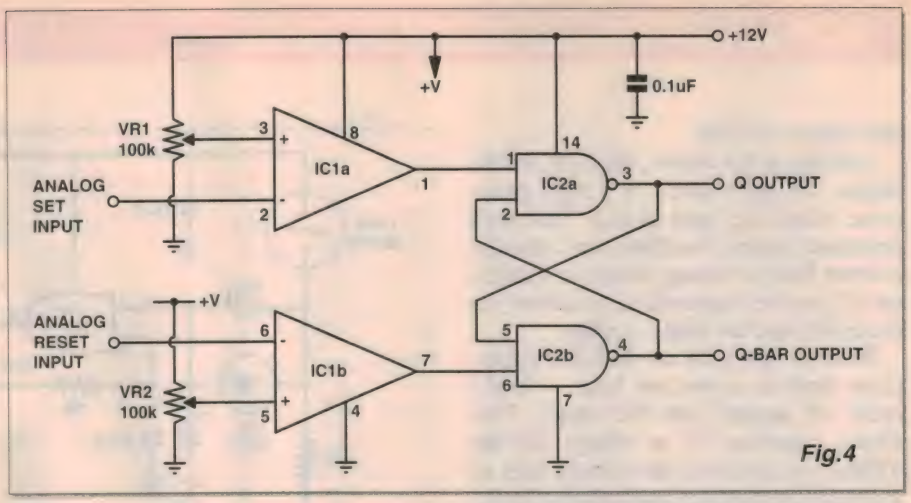


Fig.4

Now his mate isn't too far behind him, but the circuit must exclude his button hit.

Looking back to the circuit, the output of IC1c is connected to the control input of IC2a. And when the output of IC1b went high, the output of IC1c went low. This turned off the control gate IC2a, so that regardless of how hard his mate belted button SW2, no pulse would register to the IC2b/IC2c flipflop. (Of course, we can't do much if he belts the compere instead...)

Hopefully, you can see that the circuit works the same way if button 2 is hit first. Using the same logic path, the output of IC2c disables the control gate IC1a so that this time no pulse can be registered by the IC1b/IC1c flipflop.

You could extend this out further to more contestants, but that's beyond the scope of our current level. There are also better ways to do it, which we'll look at in the future.

Analog control

OK, that might be good for fun and games, but what about some serious uses and real-world applications? Flipflops are great when you have lovely nice digital signals that behave exactly as you want, but what about using an analog signal to activate a flipflop...

This circuit in Fig.4 is an example of where analog and digital circuits can and do meet. IC1 in this circuit is a LM358 dual op-amp, masquerading as a comparator. If the SET input of IC1a rises above the threshold voltage, the output of the IC1a falls low and the flipflop formed by IC2a and IC2b is triggered.

The benefits of this circuit are that you don't need a 0 to 5V logic change to get the flipflop to trigger, and you also get an indication of when the input voltage rises above the threshold level. Even if it's for just a millisecond, you'll know its passed it — that's something a comparator on its own can't do.

The input signals could come from a battery charging circuit, an LDR — the choice is yours within practical and safe limits.

The circuit can do the same for the RESET input. When the analog input signal rises above the threshold set by VR2 on IC1b, the output falls low and resets the flipflop. The only problem here though is that if *both* op-amps have low output signals, then both outputs of the flipflop will go high at the same time. This may or may not be a problem, depending on what you wish to monitor.

The most important thing to note here is that as we're using the op-amp as a bridging unit between the analog and the digital domains, we still need to operate the comparator from the same supply rail as the digital circuitry. If we connected the comparator to 12V and the digital gates to 5V, when an output of 12V hits the 5V-powered gates, you will more than likely pop that gate and ruin the IC.

The 'golden rule' is never to let a gate's input voltage rise above the supply voltage. Keep that rule and you shouldn't run into too many problems when interfacing analog to digital.

Fridge alarm

While it's important to learn how to interface analog and digital components effectively, you can do it on the 'quick and dirty' plan as shown in the circuit in Fig.5. This Fridge Alarm very simply uses an LDR to detect when the interior light of your fridge comes on and stays on for more than about 10 seconds. The IC is the ubiquitous 4093 quad dual-input NAND gate package.

As far as interfacing is concerned, here it all takes place right up at the

first input to IC1a.

Looking at the circuit, the LDR which senses the light levels is a high resistance when the light is out. This high resistance means that there isn't enough current flow to charge reservoir capacitor C1, as the capacitor is held low via diode D1 and the 10kΩ resistor.

Once the light goes on, the LDR's resistance drops to a very low level — in the order of around 100-500 ohms. This allows capacitor C1 to charge via the 470kΩ resistor. Once the voltage rises to a certain threshold set internally by the IC, IC1a (which is configured as a gated oscillator) starts running. This RC time constant gives us our 10 seconds or so.

The reason for IC1b may seem a bit hazy to start, but its there to provide a buffer between the oscillator and the power drive stage. It just ensures that we don't load down the oscillator enough to cause it to stop working or oscillate erratically.

The last two gates provide not only power drive, by connecting them in parallel, but by connecting the piezo buzzer across the gates we actually get much more output. If we connected one side of the buzzer to the output of IC1b and the other end to ground, we'd get the buzzer extending itself in just one direction. By connecting it *across* the gates, each end of the buzzer sees an inverted image of the signal fed to the other.

In practical terms, we've doubled the voltage swing across the buzzer, which gives us more volume than we could otherwise achieve from the same supply voltage. The only BUT here is that you can only do this with capacitive loads — connect up a speaker here, and you'll kill the IC.

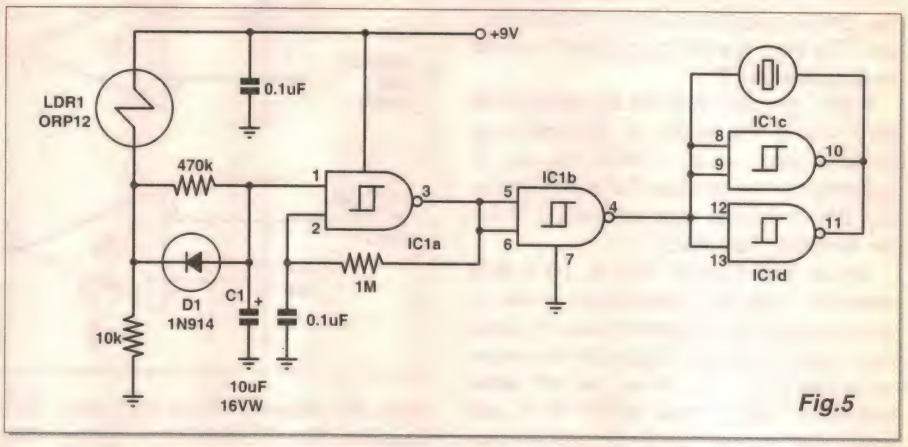


Fig.5

Personal alarm

This next circuit has been around since Noah was a lad and is a very popular design for a personal attack alarm (Fig.6). Using a single IC and four transistors, the circuit can pack a nasty wallop. This circuit again uses the parallel gate idea that we introduced in Fig.5.

Provided that you connect all inputs and outputs together of gates of the same type, or of the same IC, you shouldn't have too many problems and you get the benefit of having extra output current drive.

With this circuit we connect the outputs straight to the bases of two Darlington transistors, Q1 and Q2. Our driver oscillator is actually gates IC1a, IC1b and IC1c, with the 10kΩ resistor and 0.1uF capacitor.

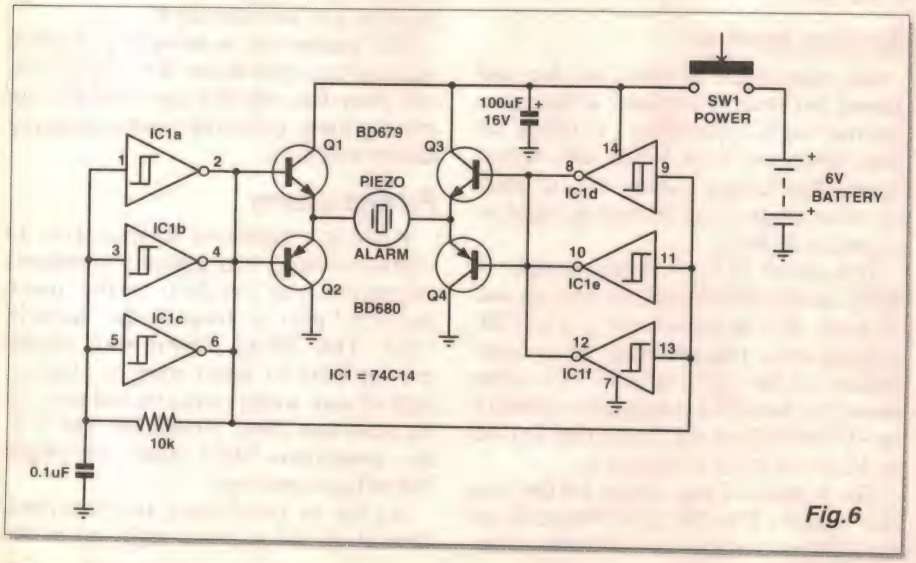


Fig.6

While the oscillator output drives one complementary pair of transistors, the other remaining gates also connect to the output of our power oscillator, inverting the output signal and driving a second complementary pair of transistors.

This configuration of transistors is often called an 'H-pack', because the load is connected between the two sections, forming the bar of the 'H'. While the H-pack configuration has limited applications, it is perfect for what we're doing here.

Just as with the previous circuit, we can double the output drive by doubling the voltage signal across our capacitive piezo buzzer alarm. If one side of the buzzer was anchored to ground, we would only be able to pull the other end up to the supply rail and to ground again.

However, if we can make both ends of the load rise and fall in opposite directions, we actually double the magnitude of the voltage across it. Doubling the voltage in theory would give us four times the power output, but in practice, it's around double the output power — and all from the same supply voltage.

The way the H pack works is that if the output from IC1a/b/c is high, Q1 is turned on. This also means that the output of IC1d/e/f is low, which turns on Q4. So you have a current flow from the supply rail through Q1, the piezo buzzer, Q4 and then to ground. When the signals swap the other way, Q2 and Q3 switch on and the current now flows in the opposite direction — i.e., through Q3, the buzzer, Q2 and then to ground. We'll use this circuit again some time in some different roles.

OK. I've well and truly run out of room, so we'll continue this next month. ❖

#102

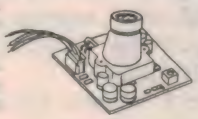
COMPUTER CONTROLLED LASER LIGHT SHOW

NEW Finally! An affordable computer controlled laser light show kit that is fast enough to draw pictures and even text. Includes PCB and all on-board components, software, fast (moving coil) deflection motors, mechanical parts (to hold motors, mirrors etc). Needs a computer, laser, connecting cables and a suitable power supply. Low introductory price **$300**

CAMERA - TIME LAPSE VCR RECORDING SYSTEM

Includes PIR movement detector and control kit, plus learning remote control. Combination can trigger any domestic IR remote controlled VCR to start recording when movement is detected, and stop recording a few minutes after movement stops: **$90**

CCD CAMERA BONUS SPECIAL



Tiny (38 x 38 x 27mm) PCB CCD camera, 0.1 lux, IR responsive (works in total dark with IR illumination).

Connects to any standard video input or via a modulator to aerial input. SPECIAL pack 1: standard or pinhole camera with bonus VHF modulator OR regulated 10.4V plugpack. REDUCED PRICE **$140**

SPECIAL pack 2: pack 1 PLUS video transmitter: **$155**

LOW COST IR ILLUMINATOR KIT

Allows a CCD camera or a night viewer to see in the dark. Adjustable power, 10 to 15V operation at 600mA (max). Has 42 IR 880nm LEDs: REDUCED PRICE **$30**

VIDEO SURVEILLANCE SYSTEM

NEW A ready made CCD video and **AUDIO** security system for home or business use. System has a small, low light CCD camera in a waterproof case, a 5 inch monitor and a long inter-connecting cable. The monitor has two camera inputs, allows manual or auto switching between cameras. Camera has inbuilt IR illumination and a microphone. Needs 12V/1.2A supply. Breakthrough at: **$299.**

If purchased with this system, we will include our computer case and supply (see below) for an extra **$10**.

Monitor and interconnecting lead available separately for **$130**. Note: Our $130 CCD camera can also be used with the system.

COMPUTER CASE AND SUPPLY

NEW Brand new, low profile metal computer terminal case with a small fully enclosed quality Australian made switch mode power supply: 240V AC to 12V/2A DC and 5V/5A DC. Front of case made from plastic with one small cutout that's easy to block. Rear has a few cutouts and IEC (I/P and O/P) connectors, fuse and switch. Off white in colour, size: 50(h) x 360(w) x 380 (d) mm. Great for projects, CB power supply etc. **$20**

DIGITAL VOICE RECORDING MODULES

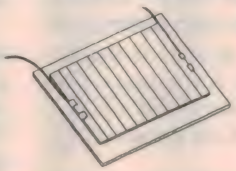
Small recording modules as used in message recording greeting cards. Powered by watch batteries (included). Also includes a suitable mini electret microphone. 6 second module: $9

POCKET SAMPLER KIT FOR PCs

See EA August 96. Data logger/sampler kit that connects to a computer's parallel port. Takes samples over a 0-2V or 0-20V range, at intervals from one per hour to one per 100uS. Ideal to monitor battery charging, can also be used as a basic low frequency (to about 5KHz) oscilloscope! Kit includes all on-board components, PCB, plastic box and software on 3.5" disk: **$25**

12V - 2.5W SOLAR PANEL KIT

US amorphous glass solar panels only need terminating and weather proofing. Includes clips and backing glass. Very easy to complete. Size: 305 x 228mm, Voc 18-20V, Isc 250mA. **$22 ea, 4 for $70**



Efficient switching regulator kit also available: suits 12-24V batteries, 0.1-16A panels, **$27**. Also available, simple shunt regulator kit **$5**

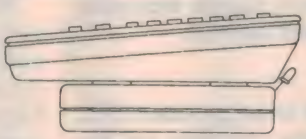
PRICE RISE NEXT YEAR

Our accountant says we must increase all our prices by 10%, from January 1997. **So buy now and avoid the price rise!**

MASTHEAD AMPLIFIER

High performance low-noise masthead amplifier covers VHF-FM-UHF and is based on a MAR-6 IC. Includes two PCBs, all on-board components and a balun former. REDUCED PRICE: **$15** for basic kit. Suitable plugpack **$10** Waterproof box for masthead amplifier: **$2.50**, plastic box for combiner: **$2.50**

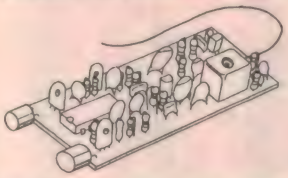
WIRELESS IR EXTENDER



This kit converts the output of any IR remote control unit to a UHF transmission that is picked up by a UHF receiver and converted back to an IR signal. Can control appliances from anywhere in your house. No extra wiring! Self-contained (includes battery) UHF transmitter is attached with Velcro strap under IR transmitter. IR sensitive pin diode picks up the IR signal; transmitter takes no power when IR remote is not transmitting!

Receiver has 2 IR LEDs, and is placed near appliance being controlled. Requires a 5-12V DC supply or, with two extra components, 24V DC. Kit includes two PCBs, all components, 2 plastic boxes, Velcro strap: **$35.** (9V battery for transmitter not supplied.) Suitable plugpack: **$10.** Components for 24V: **$1.50.**

STEREO FM TRANSMITTER KIT



FM **STEREO** transmitter for use with with electret microphones and line level audio signals. Tuning range: 88 - 108MHz, supply 6-12V, current 8mA (@ 9V), pre-emphasis 75ms, crystal locked pilot signal, S/N ratio better than 55dB, frequency response 40Hz-15kHz, , frequency stability with extreme antenna movements 0.03%, PCB size 25 x 65mm. Kit includes PCB and all on-board components, 9V battery connector, wire for antenna and two electret microphones: **$25** Plastic case to suit: **$4.**

FM TRANSMITTER KIT - MkII

Ref: SC Oct 93. Low cost FM transmitter features 100m range, excellent frequency stability, tuning range 88-108MHz, supply voltage 6-12V. Easy to build, has a prewound coil in a shielded metal can. Includes PCB, all on-board components, electret microphone, 9V battery clip: **$12 ea.** or **3 for $33** (KII).

A suitable casing so this kit can be made into a wireless microphone is also available. Includes black aluminium tube, mic pop filter, unidirectional microphone and slide switch: **$10**

MIDI KEYBOARD NEW

MIDI keyboard with 49 keys, wheel, MIDI channel, program, memory, transpose, octave, bank LSB/MSB, reset, power switch, 2-digit LED display, MIDI out jack. Needs a 9V DC power source. Size: 655 x 115 x 35mm. Computer software included. Needs a computer with MIDI interface, sound card (or external sound box) plus speakers and MIDI cable to use this excellent keyboard. **$80** 9V DC plugpack **$10.**

CENTRAL LOCKING KIT

NEW A complete central locking kit for any vehicle. Good quality, with well made actuators (Mabuchi motors). The control box can also be electronically controlled from existing UHF remote control units. Kit includes 4 actuators, electronic control box, wiring harness, screws and nuts, other mechanical parts. **$60.** The actuators have many other applications and are available separately: **$9 ea**

CODE HOPPING UHF CENTRAL LOCKING KIT with UHF REMOTE

NEW Uses code hopping encoder and decoder ICs for ultimate security. Similar to the above system, but has a built in UHF receiver. Includes two matching 2-button UHF transmitters. One button locks, the other unlocks. Receiver has 3 relays: two for central locking and one that's activated in the lock position — for immobiliser etc. Kit also includes 4 actuators, control box, wiring harness etc. **$109.**

12V GEL BATTERY CHARGER

Professional quality, large plugpack style chargers suitable for charging SLA and lead acid car batteries. Also suitable as a 13.8V/800mA DC supply. Unlike most SLA chargers, these have electronic circuitry to properly charge a battery with a constant current to its float voltage. Unbelievable pricing: **$8**

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New fresh stock of 1.2V/800mAh AA nicad batteries: **10 for $25**

New fresh stock of 12V/6.5AH SLR batteries (Hitachi): **$30 ea**

Constant current, mechanical timer battery charger: **$9**

550-100mCd @ 20mA red LEDs (about 100 times brighter than standard LEDs), as used in car brakelight arrays: **100 for $25**

16mW/940nm @ 100mA IR LEDs. (High O/P, for remote controls etc): **10 for $5**

30mW/880nm @100mA IR LEDs. (Ideal for CCD camera illumination — much better than 940nm): **10 for $6**

WOOFER STOPPER

SPECIAL WOOFER STOPPER MK2, as in SC Feb '96. High power ultrasonic sweep generator which can be triggered by a barking dog. Includes solder-masked silk-screened PCB, all on-board components, transformer, electret microphone and transformer! **$39** Approved 12V DC 1A plugpack: **$14**

THE SPECIAL: We now include one free piezo speaker. *NOTE*: We have had reports that this unit works with most wildlife, including kangaroos.

We can also supply up to three additional piezo speakers with each kit for **$6 ea.** Previous purchasers can also take advantage of this offer.

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AUTOMOTIVE ELECTRONICS

with JON LOUGHRON Assoc. Dip. Electronics

The Bosch Motronic engine management system

This month we're taking a look at the early 35-pin version of the Bosch 'Motronic' engine management system, as used in later-1980s European cars such as Volvo, BMW, Porche and Alfa Romeo. This system was also used in GMH Calibra models around 1990.

There are only two basic configurations of the early 35-pin Bosch Motronic engine management system, but when faultfinding on this system it's always a good idea to get the correct manufacturer's diagram for the vehicle. This is because even though there are only two basic versions, there are some vehicles with subtle variations...

Needless to say, the Motronic system did not appear overnight. It eventuated as a result of many years of research and development into fuel injection (closed and open loop), electronic spark timing and idle speed control by Bosch GmbH in Germany.

At this point a basic history of Bosch electronic fuel injection may be in order. I specify 'electronic', because mechanical petrol injection has been around for a very long time and that type of system has little or no electronics. Anyway the basic history of EFI and engine managememt systems for the Bosch systems is as follows:

Back in the 1970s, Bosch developed an electronic injection system called D-Jetronic. It was an analog system, fitted to VW's, BMW's and Mercedes-Benz vehicles. It controlled injection only and it had quite a unique way of measuring engine load by a vacuum sensor called an aneroid.

The system trigger was provided by an additional double set of points at the bottom of the ignition distributor, and the throttle position sensor (TPS) also was quite different. It was not a variable resistor or an idle/wide open throttle (WOT) contact, but it consisted of a set of tracks inside the TPS that are — well, probably the best way to explain them is to say that they are corrugated. As the throttle was depressed the corrugations generated a number of pulses and this provided a method for mixture enrichment under acceleration.

The L/LE/LH-Jetronic

The next Bosch electronic injection system to appear on the market was the L-Jetronic system. The main differences between the D and L systems is that L-Jetronic uses an airflow meter (vane/flap type) to determine airflow/load for the engine and the injectors are *grounded* by the ECM, instead of being provided with a positive 12V pulse (as with the D-Jetronic system).

MAKE	MODEL	YEAR
Alfa Romeo	Alfetta	84 - 85
BMW	325i	85 - 87
BMW	525e	83 - 88
BMW	535i & M535i	85 - 88
BMW	635 CSi	82 - 89
BMW	735i	82 - 86
BMW	M5	86 - 88
Porsche	911 Carrera	84 - 89
Volvo	760 Turbo	83 - 89
Volvo	740 Turbo	86 - 89

Fig.1: European vehicles which were fitted with the early Bosch Motronic engine management system.

Even though the ECM in the L-Jetronic is still of the analog type, Bosch developed hybrid technologies and circuits for the L-Jetronic to reduce the component count and increase reliabilty. If you ever get a chance to look inside the different units you will notice that, apart from the ECM's connections and physical appearance being totally different, the circuitry/system changes are also obvious.

The L-Jetronic system has no extra triggering device — it is triggered directly from the negative side of the ignition coil. The weird TPS from the D-Jetronic system is now replaced with the standard idle/WOT TPS and the main ECM connector is a 35-pin type.

The L-Jetronic system was used extensively on European vehicles and then was upgraded to the LE/LE2 system. The LE/LE2 was used again on European vehicles and the LE2 also made it to the shores of Australia, being used on the VK and XE fuel injected vehicles. This system has a 25-pin connector, to reduce the wiring in the vehicle and therefore reducing costs to the manufacturer. Remember this still is an analog ECM, although later LE versions on European vehicles did have a microprocessor. The LE3 then appeared on the market and it again was an 'L' upgrade.

The next generation used a hot-wire air mass meter, and for this reason it was called LH-Jetronic. Australia saw a derivative of this system on the VL Commodore, but the real Bosch LH was mainly used by SAAB, Porsche and Volvo. The LH systems also incorporated another ECM to control ignition timing, called an EZK (EST) unit.

During this time development of a full engine management system had been done, and this was released concurrently with some of the above systems. So the time frame was not strictly as

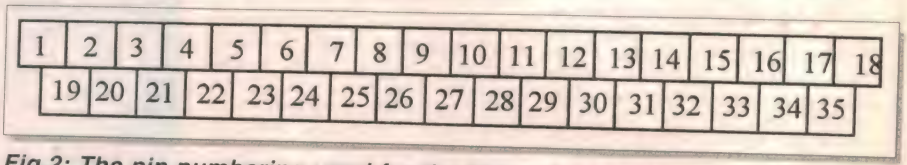

Fig.2: The pin numbering used for the Motronic's 35-pin connector.

detailed above, but this was the basic sequence of development. Some manufacturers used one or more of the later systems (LE/LH and Motronic) on different vehicles of the same era.

The 35-pin Motronic

This brings us to the early model 35-pin Motronic system. As discussed before it is an engine management system — that is, it controls fuel, spark and idle speed.

The system uses a vane-type air flow meter, which measures the volume of air drawn into the engine. The flap is deflected a certain amount (depending upon air flow) and the potentiometer inside the AFM transmits a corresponding voltage. This together with the speed impulses allows the ECM to determine engine load.

The early system used a 12V supply for the AFM, while the later system uses a 5V supply. The system uses a coolant temperature sensor to indicate to the ECM when the engine requires cold/warm enrichment. Naturally the fuel system has the standard components found on all EFI vehicles — that is a fuel pump, injectors, regulator, supply and return fuel lines, fuel rail, etc. It also has all of the associated hardware.

A summary of the vehicles that the early Motronic system is used on is shown in Fig.1, while the pinouts for the 35-pin connector are shown in Fig.2.

The triggers for the system are provided by two inductive sensors, called the RPM sensor and the TDC (Top Dead Centre/Reference) sensor. They are mounted on the rear of the engine near the flywheel, so that the pickups (sensors) can generate the AC patterns shown in Fig.3.

The RPM sensor connects to pin numbers 27 and 8, while the TDC sensor connects to pin numbers 25 and 26. The reason they have two connections each is that the sensors generate an AC waveform so each sensor has a reference line. It is also important to note that they have a separate coax shield wire; this is used to limit interference from the ignition system.

As the teeth on the flywheel pass the sensor the change in magnetic field generates the AC voltage, so there is no separate power supply to these sensors. The flywheel has 116 teeth, so the RPM sensor generates 232 pulses per revolution and the reference sensor generates one pulse per revolution — 100° before the crankshaft is in cylinder one, top dead centre position.

The winding in each of the sensors should measure approximately 1000 ohms, and the patterns can be checked on an oscilloscope or by a multimeter on the AC range.

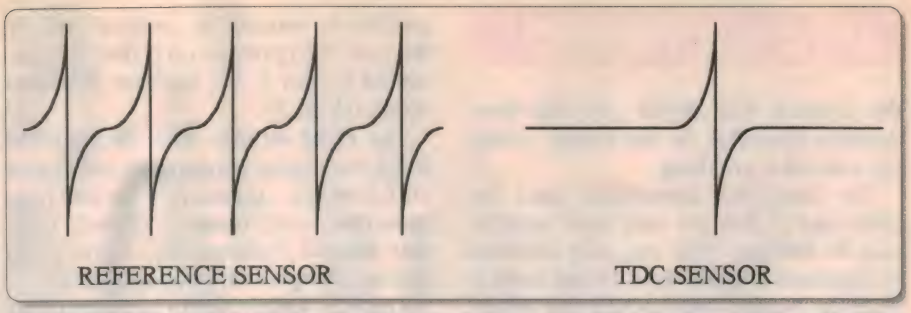

Fig.3: The early Motronic systems have two trigger sensors, the reference sensor and the TDC sensor, with AC output signals as shown. Later models have only one sensor.

One sensor dropped

On later Motronic systems there is only one sensor and the way that the sensor picks up the TDC mark is by the omission of teeth at that point. At the start of this article I mentioned that there are two basic versions of the 35-pin Motronic systems — this is the main difference between the two.

The throttle position sensor has three terminals: pin 18 is ground, pin 2 is closed throttle and pin 3 is Wide Open Throttle (WOT). When neither switch is closed (therefore earth potential is not connected to either pin 2 or 3), the ECM determines this to be part throttle mode.

It is not a coincidence that the terminals on the TPS are connected to the same pin numbers on the ECM. They are numbered this way because this numbering system was used on the earlier Bosch L and LE systems. But it should be noted that pin 18 on the TPS does not go to pin 18 on the ECM.

The Air Flow Meter is marked in the same way — pins 6, 7, 9 and 22 on the AFM connect to pins 6, 7, 9 and 22 on the ECM; see Fig.4 for the internal connections. As mentioned before when the flap is deflected a variable voltage is output to the ECM; this is on pin 7, and the voltage is calibrated to be proportional to the volume of air induced into the engine.

An air temperature sensor is mounted in the front of the AFM to indicate air the temperature. This is done so that the ECM can fine time the mixture for any change in air density.

The coolant temperature sensor is an NTC (negative temperature coefficient) device, and therefore as the engine temperature increases the resistance decreases. A table of its resistance versus temperature is provided in Fig.5.

While we are discussing the coolant temperature sensor, it should be noted that cold start enrichment is provided by the normal injectors and in addition there is a cold start injector for extra enrichment. The cold start injector is controlled by the starting circuit and the thermo-time switch, and it must be remembered that it is only invoked if the engine temperature is low enough — and then only during crank mode. A circuit diagram is provided in Fig.6.

Thermo-time switch

To ensure that the cold start injector is enabled only when the engine is in crank mode, +12V is provided to the injector by ECM circuit 50 (start circuit), and it is earthed through the bimetal contact of the thermo-time switch, via the switch body. If the bimetal switch is heated by either its heating element or engine temperature, then the contacts in the switch will be open and the cold start injector will not operate. Conversely if the engine is cold, the switch will be closed, and then

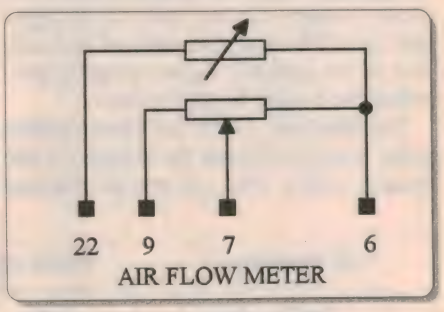

Fig.4: The connections to the air flow meter (AFM), which also includes the air temperature sensor (ATS). Pin 7 is the AFM output, while pin 22 is the ATS output.

TEMPERATURE	RESISTANCE
10 deg C.	5000 Ohms
20 deg C.	2500 Ohms
80 deg C.	300 Ohms

Fig.5: The air temperature sensor has a negative temperature coefficient, as shown by this temperature-resistance table.

the injector will operate for the time duration specified on the switch while the vehicle is cranking.

One fault that sometimes must be addressed is that the cold start injector may be leaking. This can only checked by disconnecting the injector and testing both the thermo-time switch and injector electrically; then if necessary remove the injector from the vehicle for testing. The symptom for the above problem would be a vehicle that is constantly 'running rich'.

The fuel pump relay is controlled by pin 20 on the ECM. When the engine is cranking or running, pin 20 sinks to ground to energise the fuel pump relay — which in turn energises the fuel pump. This forms the safety circuit to ensure that if the engine is switched off, the fuel pump is also disabled.

The main power relay is energised by the ignition switch and once energised, the +12 volt supply is applied to pin 18 and 35 of the ECM — and also to the injectors, ignition coil, idle speed control valve and the fuel pump relay.

The Motronic system is a full engine management system, so this means apart from controlling the fuel injection it also controls ignition timing and idle speed. Ignition control is provided by the ECM on pin 1. This is quite ironic, because on earlier L and LE systems, the ignition coil is attached to pin 1 but these systems did not control the ignition coil. The negative side of the coil, that is the primary signal, actually provided the trigger for the system...

The Motronic ECM has the inductive pulse generators form the trigger for the system, and it does not use an external module to control the ignition coil. In this case the ignition coil is directly controlled by pin 1, via a power transistor inside the ECM.

The ECM receives information about RPM, the engine temperature and engine load from the external devices and from these details and using a relatively complex internal 'ignition map' it constantly updates the ignition timing and dwell.

The Idle speed control is achieved by the idle speed valve, which bypasses air around the throttle body. This is done to compensate for load variation at idle, and also to control the idle speed during the warm-up cycle. When the idle contact is closed the idle speed is maintained by the ECM on pins 33 and 34.

The resistance of each of the windings in the idle speed valve is approximately 20 ohms. The ECM varies the duty cycle of the waveform applied to the idle speed controller according to the engine temperature and also the load on the engine — such as the headlights operating or the rear window demister in use.

Basic checks first

When you encounter a vehicle with problems, remember the basic system checks must be performed first, as with any fuel injected vehicle. These tests include the standard fuel and air system tests.

The fuel pressure must be measured because the pressure is set by the fuel pressure regulator, and the ECM does not compensate for any pressure variations. A residual pressure test should also be performed to ensure the injectors are not leaking, and a volume test should done to prove the integrity of the fuel pump and associated circuitry.

If the air intake system has any air leaks, the engine may exhibit a rough idle or rough running. This is because with an air flow meter on the system, any air that enters the engine through a leak after the AFM is not measured — the AFM flap will not be deflected for that air. As a result the engine will have a lean mixture.

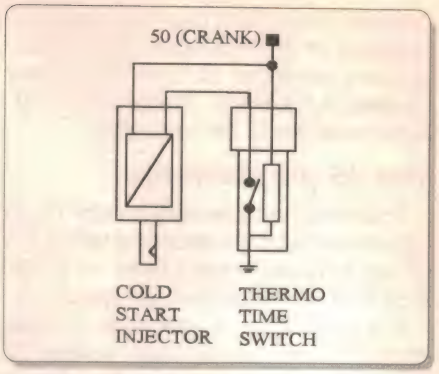

Fig.6: The wiring configuration for the thermo-time switch and cold-start injector, which are both energised from the circuit 50 (crank) line.

When both the fuel and air systems prove to be OK, then the electrical system can be checked. If you have a rough running vehicle or a vehicle with a rough idle, then you may have to check and verify the individual input and output components. If on the other hand you have a 'non start', then there a couple of quick checks that can be performed to reduce the labour bill.

With a non-start vehicle, providing the fuel and air systems prove OK and there is no spark or injection, then you could start by checking the triggers for the system and also power supplies, relays and grounds. The triggers can be tested while the engine is cranking, using a scope or multimeter, to see if any AC signal is being generated. As mentioned previously the resistance of each of the sensors should be approximately 1000 ohms.

The +12V power supplies to the ECM are on pins 18 and 35, and the grounds are on pin numbers 5, 16, 17 and 19. The relay control and connections are provided in Fig.7.

Well, that wraps it up for another month in the world of automotive electronic systems. As you can see the early 35-pin Bosch Motronic unit does quite a bit of techo stuff during one engine revolution, and the later 55-pin version does even more. So good luck with faultfinding on the system.

But always remember to do the basic tests first. Then you can crank up the oscilloscope, decoders and other high tech gizmos.

Until next time, 'bye. ❖

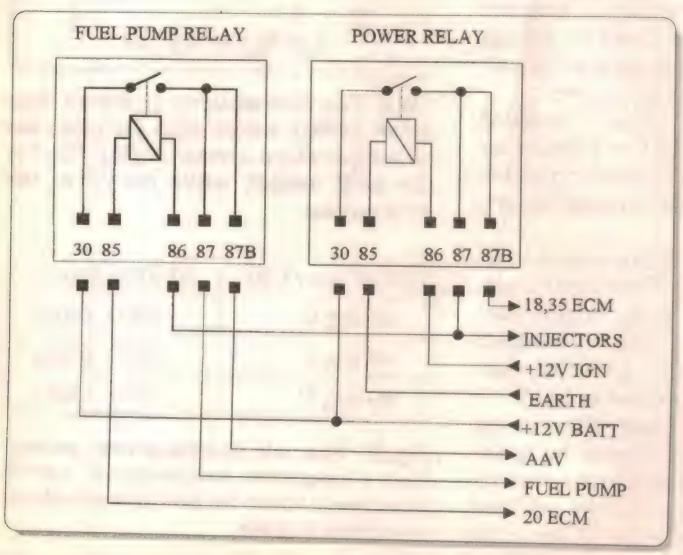

Fig.7: The connections for the power relay and fuel pump relay. The power relay is energised by the ignition switch, while the fuel pump relay is energised when the ECM grounds pin 20.

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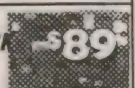

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NEW KITS NEW KITS NEW KITS NEW KITS NEW KITS NEW KITS

HIGH ISOLATION CURRENT ADAPTOR

K10810 $59.95

NO PICTURE AVAILABLE AT TIME OF PUBLICATION

Making use of a new Hall effect sensor available from Fastron technologies, this simple project enables you to take mains current measurements of up to 10 amps in complete safety, with readings accurate to 1%. Due to the high bandwidth of the sensor used, you can also use your scope to examine and measure any waveform components from DC up to 25kHz- again in complete safety. ***EANov'96***

A POCKET SIZED "MINIOSC" AUDIO OSCILLATOR

ALL NEW

K10805 $45.25

NO PICTURE AVAILABLE AT TIME OF PUBLICATION

Here's a high performance audio oscillator design that is small enough to fit literally in a shirt pocket. Despite its size, it produces low distortion sine or square wave at any frequency from 41Hz to 18kHz, and runs from a standard 9V battery.
EA DEC '96

HIGH PERFORMANCE PLAYMASTER PREAMP

ALL NEW

K10815 $291.95

NO PICTURE AVAILABLE AT TIME OF PUBLICATION

SHORT FORM K10816 $188.95

The Playmaster Pro Series range of high-quality hi fi gear- the Pro Series Four reference premap. Developed from the respected Pro Series Two control preamp, this new design offers a larger number of features including infrared *remote volume control*, an even simpler construction method, and as before, first-class performance. ***EA DEC '96***

PC-DRIVEN ARBITRARY & FUNCTION GENERATOR

ALL NEW

K10820 $162.25

NO PICTURE AVAILABLE AT TIME OF PUBLICATION

Need to generate signals with special formwaves, for testing? Here's the design for a PC-driven unit that will cost you much less than commercial function of arbitrary waveform generators, but can produce signals of virtually any desired waveform at frequencies from 0.25Hz to beyond 100kHz. ***EA DEC '96***

Video Transmitter and Receiver

ALL NEW

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K10795 Transmitter $68.45

K10796 RECIEVER $70.95

BUILD A VGA DIGITAL OSCILLOSCOPE

K10790 $269.95

SC AUG '96

One of the real attractions of this digital scope, based on a VGA monitor, is that you don't have to peer at the display- it is large, bright and the different coloured traces and graticule make it easy to interpret what's happening.

LOW COST POCKET SAMPLER

$32.95

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INFRA-RED STEREO AUDIO LINK

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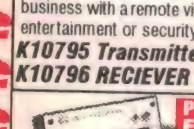
EA JAN'96

PC DRIVEN EGO SENSOR ANALYSER



K10735 $39.45

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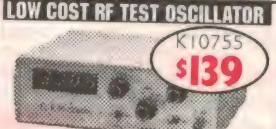
LOW COST RF TEST OSCILLATOR



K10755 $139

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PC- DRIVEN ELECTROCARDIOGRAM

K10680 $29.95

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EA JULY '95

GEIGER COUNTER

K10715 $168.95

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SC Oct'95

Geiger Tube available at $119.00

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K10760 $47.95

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EACPUD96

INFORMATION CENTRE

by PETER PHILLIPS

Solving a few assorted mysteries...

This month we identify the manufacturer and laptop computer system I discussed last month, and describe what has been done to fix it. We also solve the mystery of the strange sounds made by meteors, give an answer for the October star puzzle and brag about an anti-gravity discovery. There's also the usual range of reader letters.

Last month I described a range of problems I was having with a new laptop computer and docking station I recently purchased to replace my desktop system. I also pointed out that I had sent a copy of the column to the manufacturer. This month I'm continuing the story, by identifying the manufacturer and the product, and also by describing what has been done to solve the problems.

But first, why am I doing this? As I see it, a technical journalist has a responsibility to keep readers informed, and to act as a balance against advertising hype, particularly if a product has a relatively high price tag. In this case, the system cost over $12,000, with additional essential software and hardware bringing the total to around $14,000.

Anyone thinking of buying a similar system is therefore likely to want to know as much as possible before making such a purchase. So if I didn't describe what I know to be useful information, I would not be doing my job. It's certainly not my intention to use this column to denigrate (or promote) any product, but just to report facts that could be useful to readers. So, getting on with the story...

The manufacturer is Toshiba, the computer a 720CDT Tecra and the docking station a model V-Plus. To keep things brief, I won't repeat the problems, except to say they have caused me a lot of stress and loss of income. You might like to refer back to last month's column for the details, which include the cost of insurance being nearly double the advertised cost, and a range of operational difficulties with the system.

When Toshiba Australia received my letter and copy of last month's column, I was advised that the matter would be dealt with. Later that week a Toshiba representative phoned me, leaving me with the distinct impression that in his opinion *I* was the problem. I tried to explain that some of the problems could not possibly be caused by the operator, and repeated my request for someone from Toshiba to come to my office and at least examine the system.

This was refused, and the offer of me bringing all my office equipment to Toshiba was repeated. I pointed out that I believed the product was flawed, and that it would be in everyone's best interests for someone to come to me, a distance of about 40km.

Given this claim by Toshiba: "This warranty has been designed to provide the industry's most complete, customer-driven resource to make Toshiba product purchases a positive experience for every customer", I was left feeling angry and frustrated.

However, I later received a phone call from the computer dealer I had purchased the system from. He explained that Toshiba had asked him as a favour to visit my office and sort out the problems. Because the dealership is not a certified Toshiba Technical Centre, Toshiba temporarily warranted him against the unlikely but possible damage that could result from upgrading the system BIOS. He subsequently visited, did the BIOS upgrade, installed a parallel card and examined my system.

He found nothing wrong with the setup, and listened as I outlined further difficulties I was having. These included being unable to access the alternative character set via the numerical keypad on my relatively new and expensive AT-style external keyboard, and that its CTRL-ALT-DEL reset combination did not work. He suggested I replace it with a PS2 keyboard.

He could not explain why the system had locked up, when I tried to copy files from the laptop's hard drive to the 3.5" floppy disk in the docking station. The 'hang' occurred after Windows 95 had reported the floppy disk to be write-protected, and I had removed the protection and clicked OK. As well, he was not able to explain the other 'hangs' I was experiencing, but agreed it was not user error. He also experienced a hang while working on the system.

As well, he could not install a serial card in the docking station as it did not have enough reserve power to drive it. At the time the only other peripherals in the station were a simple parallel port card and a CMOS 1.2GB hard drive. As you'll read, I've since removed the hard drive. To give me an extra serial port (the system only has one), he lent me a PCMCIA card.

Later Toshiba's General Manager phoned and enquired if I was now happy with the product. I explained that I was far from happy, and gave my reasons. He advised me he would examine the matter further and get back to me.

Before writing this month's column I tried unsuccessfully to contact the manager, to advise him that the above-mentioned hard disk in the docking station had 'crashed'. Tests suggest that the partition information on the drive is scrambled, but that its interface and drive electronics are functioning correctly.

This drive is about nine months old, and has worked perfectly until now in my previous system. It's impossible to determine what has caused the crash, but given the litany of difficulties I've had so far, it seems reasonable to suspect the computer system. The new BIOS, maybe?

After all, the drive was functioning when the dealer came, and had worked well ever since fitting it to the docking station. I had previously used it to back up all my important files from the hard disk in the laptop. The next time (about a week later) when I tried to access it, it no longer 'existed'. In between times, I had done absolutely nothing other than use my usual computer programs from the laptop's hard disk.

A Toshiba support technician could not help, but told me he would ask the company to give me a newer version of

the docking station. He later phoned confirming that a new station had been ordered and that he will check it thoroughly before delivery.

On the day the technician phoned, I also received a letter from Toshiba stating that I should contact the dealer if I needed anything further, on the basis that the system was fully functional when delivered. The letter pointed out that this could be a chargeable service if the dealer needs to come to my office. It also stated "that your current difficulties are to do with your configuring of added hardware and software."

It made no mention of the possibility of the equipment having a problem, although at the time of writing the letter, the manager was unaware of my hard disk crash. As well, I doubt if he was fully aware of the range of problems I had experienced that could not be attributed to the user. A communications gap perhaps, although I had tried hard to make my points known.

So what did I expect from Toshiba? Given (1) it was an expensive system, (2) that I was describing the events in a popular magazine and (3) the manufacturer's warranty claim of a 'customer-driven service', I guess I expected a bit more. I at least wanted Toshiba to investigate the possibility of the system having a problem, and not to merely blame me for the difficulties.

As things stand, even if the new docking station fixes everything, I'm left with a crashed hard disk and a lot of lost time and money (admittedly some caused by me trying to add hardware and one simple piece of software). As well, I now need to buy a PS2 keyboard.

Hopefully the new station will be able to power a serial port, although any revisions are likely to be in the firmware only, not the power supply. If I can't get the additional serial port, I'll have to ditch a recently purchased interface to my fax machine, along with my near-new Honeywell keyboard. I'll also need to buy a PCMCIA modem, to at least get back on the 'air'.

Incidentally, the computer has an inbuilt fax modem which is waiting Austel approval. Austel has advised me any delays are the result of the manufacturer, not Austel. Apparently the Australian standards are indeed different to those in other countries. There's still no word about when the modem will be approved.

And what about the problems I've had when adding hardware and software? If I can't add anything more to my new system because of its 'fragility', what's the point in owning it? After all, I bought it to extend my operational activities. This is something I've been doing for nearly 20 years. I admit there's always a learning curve, but surely today's equipment should make this easier, not more difficult.

If there's any message in this, it is surely that (1) an expensive name-brand is not a guarantee of performance and (2), you should make sure when you buy a computer system that the dealer is technically competent and able to support you. If you buy a Toshiba product, make sure the dealer is a Certified Technical Centre. This is not always the case.

On a positive note, I can say that the laptop itself has worked well. In fact if that was all I had purchased, I would not be writing this. As well, the technical support team at Toshiba have been friendly and supportive, and have genuinely tried to help. My sincere thanks to them.

So there's the story, reported as accurately as I can. I'll let you draw your own conclusions, but I think anyone reading this will wonder: if an experienced user has the problems I've described, what about a novice?

I'll keep you informed on further developments, but for now here's an update on the anti-gravity controversy started by Wayne Shirley in May.

Anti-gravity discovery

Our first contribution is not a letter, but an abbreviated extract from an article in *The Age*. Supporters of Wayne Shirley's view that there's a relationship between anti-gravity and superconductance (May 1996) will cheer wildly, while opponents (September '96) will surely wonder:

Scientists in Finland are about to reveal details of the world's first anti-gravity device. About 30cm wide, the device is said to significantly reduce the weight of anything suspended over it. The claim has been rigorously examined by scientists, and is due to appear in a physics journal. According to the research leader, Dr Eugene Podkletnov, the discovery was accidental and emerged during routine work on superconductivity.

What makes this claim different to other so-called anti-gravity devices is that it has survived intense scrutiny by sceptical, independent experts, and has been accepted for publication by the 'Journal of Physics-D: Applied Physics' published by Britain's Institute of Physics. Even so, most scientists will not feel comfortable with the idea of anti-gravity until other teams repeat the experiments. Some scientists suspect the anti-gravity effect is a long sought after side-effect of Einstein's general theory of relativity.

The Finnish team is expanding its program to see if it can amplify the anti-gravity effect. The team has measured a two percent drop in the weight of objects suspended over the device, and double that if one device is suspended over another. (*The Age*, September 2, 1996)

I also have another article from an unidentified newspaper, that says: *Scientists were watching the spinning disc of superconducting ceramic suspended in a magnetic field of three electric coils, all enclosed in a low-temperature vessel called a cryostat, to see if the disc would lose its electrical resistance when subjected to low temperatures. "One of my friends came in while smoking a pipe," Dr Podkletnov told the London Sunday Telegraph. "He put some smoke over the cryostat and we saw that the smoke was going to the ceiling all the time."*

So, given that the articles are not dated as April 1, it seems that Wayne's views are getting support from Finland. Of course there's a long way to go, and we might find the whole thing is a hoax anyway. But doesn't it strike you as being rather amazing — not that anti-gravity might have been discovered, but that as presented in this column in May, the discovery, if true, links anti-gravity and superconductance. You read it here first, folks!

And staying with things metaphysical...

Star puzzle

In October I included a puzzle sent to me by a reader (Linden Breswick, of Launceston in Tasmania). Linden admitted to having tried and failed for many years to solve the problem, so I threw it over to our readers.

I expected a few replies, but I must admit I didn't expect so many people to not only solve the puzzle, but to then take the trouble to write. Many people used a computer program to solve it (that's cheating!), while others did it manually. It appears there are 960 solutions, but allowing for rotations and mirror images, there are still 80 unique solutions. One of these is shown in Fig.1.

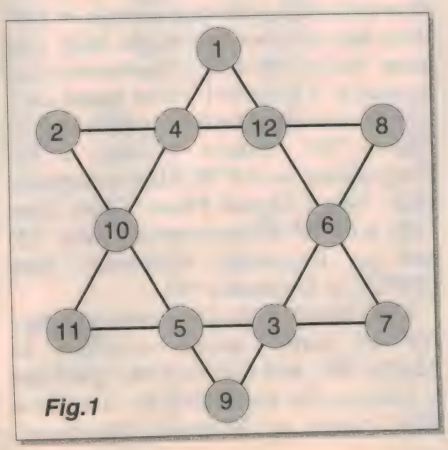

Fig.1

According to Andy Wood (Sydney NSW), this puzzle was presented in Martin Gardner's regular Scientific American column over 20 years ago, with the enticing extra of making the outer points of the star also add up to 26. Andy's answer did this, and he pointed out that according to Gardner there are 12 solutions for this, although even with the aid of a computer program, Andy could only find six.

My thanks to everyone for taking the trouble to write (or fax) their answers. And I'm sure Linden will now sleep just that little more soundly.

Electrophonic sounds

In August, I included a letter from a reader describing the sounds made by meteors as they enter the upper atmosphere. Another reader (Dr Colin Keay, Research Associate in Physics, Department of Physics, University of Newcastle) has kindly sent me copies of papers that explain the phenomenon. The papers are too long to include here, but this summary might help. It comes from a paper titled Anomalous Sounds from the Entry of Meteor Fireballs by Dr Keay. It's dated October 1980, and the copyright is held by the American Association for the Advancement of Science:

A very bright fireball observed over New South Wales in 1978 produced anomalous sounds clearly audible to some of the observers. An investigation of the phenomenon indicates that bright fireballs radiate considerable electromagnetic energy in the very-low-frequency (VLF) region of the spectrum. A mechanism for the production of VLF emissions from the highly energetic wake turbulence of the fireball is proposed.

Trials with human subjects revealed a very extended range of thresholds for the perception of electrically excited sounds among a sample population, particularly when the VLF electric field excites surface acoustic waves in surrounding objects. This fact, together with variable propagation effects and local conditions, can account for the sporadic distribution of reports of anomalous sounds from fireballs and auroras.

The other paper Dr Keay sent (and wrote) is more recent (1995), and concludes with:

The increasing scope of phenomena involving the transduction of ELF/VLF EM radiation into audible sound demands the use of a collective term for this new field of study. It is proposed that it should be known as geophysical electrophonics.

In conversations with historians and classical scholars it is becoming evident that geophysical electrophonics can provide a physical explanation for many episodes hitherto assumed to be supernatural, such as celestial noises accompanying tongues of fire and similar manifestations, described in many scriptures, scrolls and ancient writings (a very good example is Acts 2:2 in the Christian Bible).

Thank you, Dr Keay, for sending us this information. The papers make very interesting reading (for instance the total radiated power from a typical meteor appears to be in the order of 2×10^{10}W). So if you hear things going whoosh in the night, relax. It's only a huge meteor letting off gigawatts of ELF/VLF EM radiation!

68HC11 projects

The next letter seeks information on projects based on the 68HC11 microcontroller:

I have been a regular reader of your magazine for a number of years and have found many of your projects to be extremely interesting, and often very useful. It's for this reason I hope you may be able to help me locate some applications or projects based on the Motorola 68HC11 microcontroller. I have copies of the standard reference and data books, but these lack any simple microcontroller projects.

I am interested in using transducers as a part of the input, with possibly a PIA, EPROM and further interface circuitry to achieve some form of control. I would greatly appreciate any help you can give. (Jeffrey Renwick, Mt Eliza, Vic)

I can't find any project based on the 68HC11 microcontroller Jeffrey, but we have certainly published a range of projects and reviews that might help. Our most recent 68-series microcontroller project is a Reaction Timer based on a 68705 microcontroller, published in March '94. Others include a PC Programmer for 68705 Microcomputers (Jan '94), a Digital Photo Timer (Dec '93), a 68705 Microcomputer (Sep '93) and an Electronic Christmas Tree (68705) in December '92.

I reviewed a development package for 68 series microcontrollers in March '93, and I'm told this package is continually expanding to cater for a wide range of Motorola microcontrollers. While it's not a project, this package lets you develop the software without needing to build the hardware or even program the micro. For further information contact Oztechnics, of PO Box 38, Illawong, 2234, phone (02) 9541 0310.

Corrosion

It's not often we get questions more related to chemistry than electronics, but the next letter asks two questions that are likely to be of interest to many readers:

I recently paid $240 to have my reverse-cycle air conditioning system repaired. The copper capillary tubing had corroded, allowing the gas to leak out. According to the repairer, the corrosion was due the proximity of the sea. To prevent this happening again, do you think it would be advisable to paint the tubing with a bituminised paint?

I also propose putting up a two-metre whip, and later an HF antenna mounted on the top of an aluminium mast, which will be supported by a galvanised angle iron bracket mounted high up on a brick wall. Is there any adverse effect likely to occur by bolting the aluminium mast to an iron frame or bracket? It has been suggested a coating of bituminised paint should be applied between the iron and the aluminium. Could you advise? (M. Gell, Glenelg, SA)

I spoke to a chemical engineer about your first problem, Mr Gell, and his suggestion was to use a marine paint for your copper tubing. This is what the Navy does, so it should work in this case. I'm not sure about bituminised paint, so I won't comment.

Regarding the antenna installation, there is a problem with butting aluminium and galvanised steel. Under the right conditions, the two metals react, which causes the galvanising to corrode. In fact, the two don't even have to be butting, just in close proximity, as I discovered when I noticed the galvanised guttering on my house corroding quite rapidly. According to others, this was caused by rain from the aluminium roof.

However, I have a similar antenna installation to the one you propose, with an aluminium mast held by an iron bracket (not galvanised). This installation has stood the test of 20 years, although my house is about 15km from the sea. Before assembly, I painted the iron bracket with a good quality metal primer. But I have to say

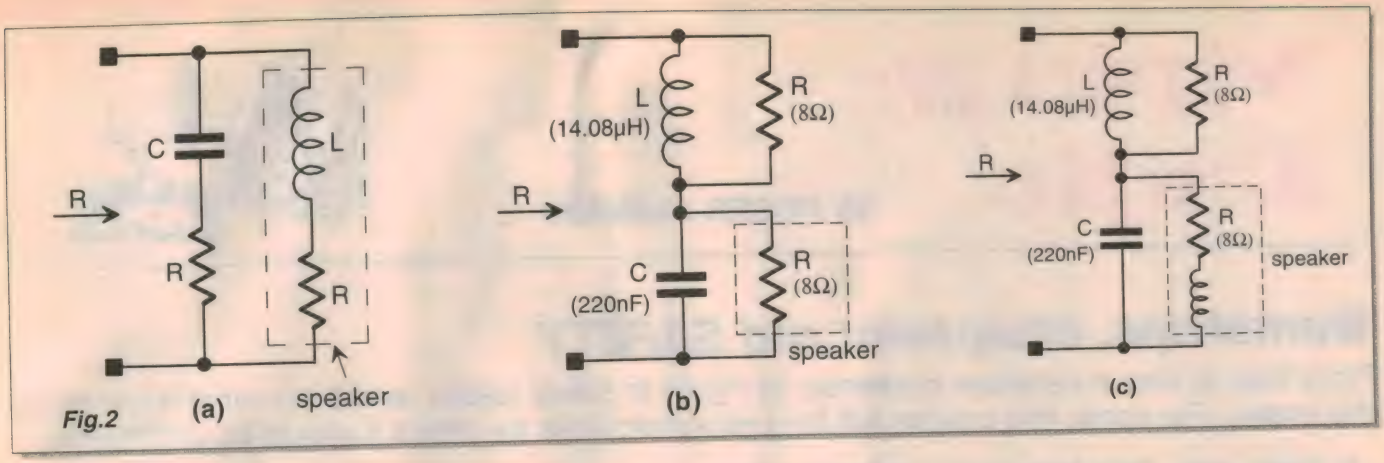

Fig.2

I'm not an expert on this, so perhaps other readers might like to comment.

Zobel query

In the August issue we discussed Zobel networks at some length. But according to our next letter, there's something not quite right with the equivalent circuits we presented:

Such well respected names as Harry Freeman and Neville Thiele draw attention, and they certainly drew mine to the Zobel discussion in your August 1996 issue. I have just one query — how was the speaker system, represented as a series LR network in Fig.2(a), transformed to a simple R in Fig.2(b)? Clearly something pretty clever has gone on and I, for one, would love to know what it is. (John Hill, Kew, Vic)

As you can see in Fig.2(a) and (b), the speaker is represented differently. After reading John's letter, I looked at the original text sent by Neville Thiele to make sure we had reproduced the circuits correctly. We have, so all I can assume is that Fig.2(b) should be redrawn as in (c). That is, the R should include an L.

To be absolutely consistent the L might best be shown in parallel with R, but for the purposes of the diagram, I don't think this matters. What does matter is that it's included somehow. The caption in the original text says that the resistor representing the speaker shows its nominal resistance, so I assume the inductance is implied.

Old electronic gear

Instead of throwing away your old equipment, consider this:

Could you please place this short advertisement in your column, in the hope readers might be able to help me. 'Wanted — any electronic gear or old radios. Don't throw them away, throw them my way. By the way, can't pay till another day.'

I am sitting at home in a wheelchair with nothing to do except watch TV, which bores me. By the way, is there a list of all projects published by EA? And where in this state can you buy valves? (Barrie W. Taylor, 62-125 Herdsman Parade, Wembley 6014, phone 09 387 7519)

Glad to help, Barrie. Hopefully you'll get quite a response, as most of us like to think the gear we get rid of ends up being useful to someone else. As you requested, I've included your address and phone number for readers to contact you directly.

We don't have a complete printed listing of all our projects (no one has ever asked), but we do have an annual index in the January edition of the previous year's projects and other articles. There's not much point having a complete listing, as a lot of our older projects are now of no interest, or parts are no longer available. Most larger libraries (try a TAFE library) have copies of the magazine, so you could perhaps browse through the January editions.

If you have a computer and modem, you can also log onto our bulletin board (02 9353 0627), where you'll find our project index database.

Valves are no longer easily obtainable, but you can get them from some of our 'Vintage Radio' advertisers, such as Resurrection Radio, Vintage Wireless & Radio Co., and L.E. Chapman. Otherwise, keep looking in our Marketplace section, as sometimes there are advertisements listing valves for sale. Or perhaps a reader can help you.

What??

The question this month is another from Peter Stuart, who writes:

A quartz crystal manufacturer made too many crystals and wants to store them in a nearby warehouse. The crystals are each packed in a small cardboard box, one centimetre cubed. There are 1,000,000,000 crystals to be stored. The warehouse manager insists the crystals must be glued together into a cuboid, which is to be painted all over (including the base) with green paint. (A cuboid is a rectangular solid, the length, width and height of which are not necessarily equal.)

The warehouse manager also insists the dimensions of the cuboid (measured in centimetres) contain no zeros. The manufacturer has only eight tins of green paint and each tin will cover only 100 square metres.

What dimensions will the cuboid have to be?

Answer to November's What

The answer is 6.59W. The trick with this question is to use the equation for two parallel resistors: (R1xR2)/(R1+R2). For the left network, notice that if you pair them correctly, the sum of the two values is 10. So 1//9 is 9/10 = 0.9W. The next two in this network gives 21/10 = 2.1W. These two values in parallel give 1.89/3 = 0.63W.

For the right-hand network, using the same principle, you end up with 1.6Ω in parallel with 2.4Ω. You might need pencil and paper to find the resistance of these two in parallel. That is (1.6x2.4)/4 = 3.84/4, which equals 0.96Ω. Adding all these values together gives 0.63 + 0.96 + 5 = 6.59Ω. ❖

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As part of our service to readers, *Electronics Australia* operates a Reader Information Service Bulletin Board System (BBS), which makes available a wide range of useful information for convenient access and rapid downloading. You can also leave contributions to some of our columns.

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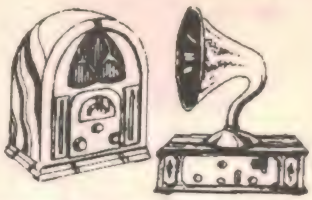
Vintage Radio

by ROGER JOHNSON



Workshops, equipment and SAFETY

From time to time it becomes necessary to return to safety issues, and that's what we're doing this month. For some, this column will be a refresher; while for others it should be informative.

In former times, dad's home away from home was quite often an extension to the garage or 'motor shed'. Nowdays things have changed somewhat. We no longer have the universal 'quarter acre block' with the house, sleep-out and detached garage/motor shed with ample yard space. Courtyard homes, home units, carports and contempory style homes now mean that the ham shack or the workshop is anything from a spare room, to a garden shed, to a corner of the carport or an old style 'shed'.

Workshop layout

No matter what the locale or the layout, the environment MUST be safe. Employers have a responsibility to provide a safe working environment, and there is no reason why individuals should not extend the same principles to their own home.

In Fig.1 there is a stylised diagram of a 'perfect workshop' layout from around 1933. Whilst this is a pleasant trip down memory lane, we can still use it to good effect to illustrate useful safety aspects.

Firstly, there is space. Such elegance may be impractical in these times, but wherever the locale, it should remain as uncluttered as possible. Notice the absence of several dozen complete or canibalised chassis strewn about the floor, such that moving about becomes an exercise in crossing a minefield.

Secondly there is a window! Natural light is the best of all. if a window is not feasible, how about a skylight?

Thirdly, the workbench (1) is quite high, with a stool (7) to match. If one is to be consistantly up and down from the bench in a fetch-and-carry mode, a high bench and matching stool are often easier physically, and less tiring upon the body.

Fourthly, there is no myriad of cables — e.g. power flex — to become entangled in one's feet to either trip one up or cause a piece of equipment to crash to the floor.

Fifthly, the hand tools (6) are out of the way, or else in a tool drawer (3).

Sixthly, there is the power supply, shown here as the battery compartment (10), and the associated terminal and distribution board (12). As shown these should be out of the way and at the back of the work bench.

Lastly, there should be adequate artificial lighting (21 and 22), although nowadays a couple of fluorescent tubes might be more effective.

With the advent of new technologies, second-hand test equipment such as a signal generator, a CRO, an audio oscillator and even a frequency counter can be had quite cheaply and are more than useful for most home enthusiasts. Therefore, a raised shelf at the back of the workbench housing these items is the safest, with both the electrical leads and the connecting cables out of the way and taking up little space.

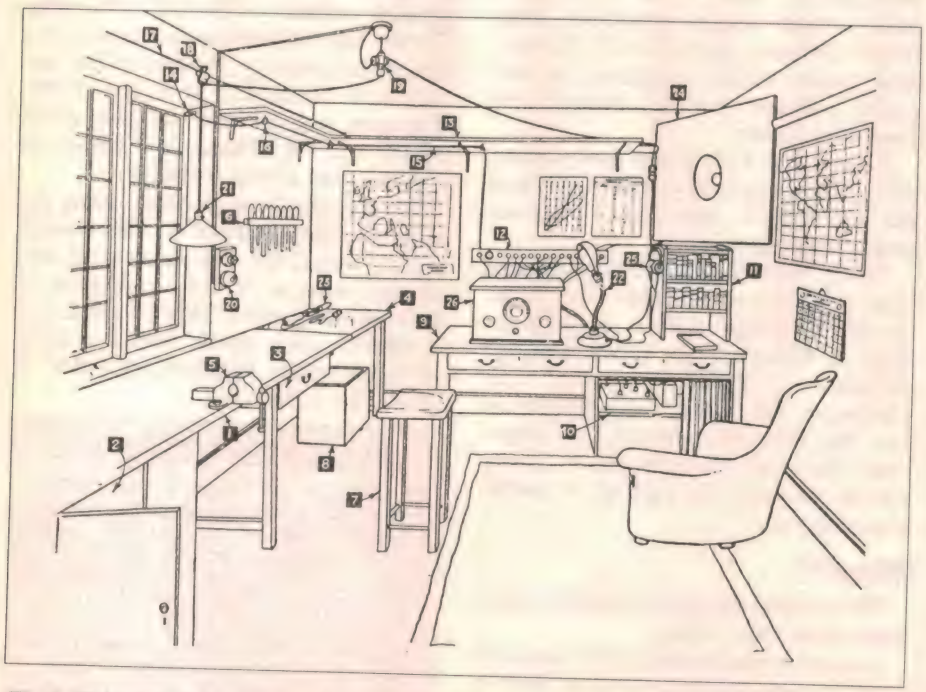


Fig.1: This drawing appeared in Practical Wireless for 11th March 1933, illustrating the ideal workshop. The legend, where applicable, is explained in the text.

Wiring

A check with my own state electrical authority revealed that it is illegal to 'expose any of the reticulated mains wiring'. This restriction extends to such simple tasks as substituting a ceiling rose with a batten holder, or replacing a single power-point with a double outlet, and applies to anyone except a licensed electrician.

Accordingly, this magazine can therefore neither countenance nor condone anyone performing any alterations to existing wiring, now matter how well 'informed' that person might think he or she may be.

However, it is certainly permissible to use the distribution boards that plug

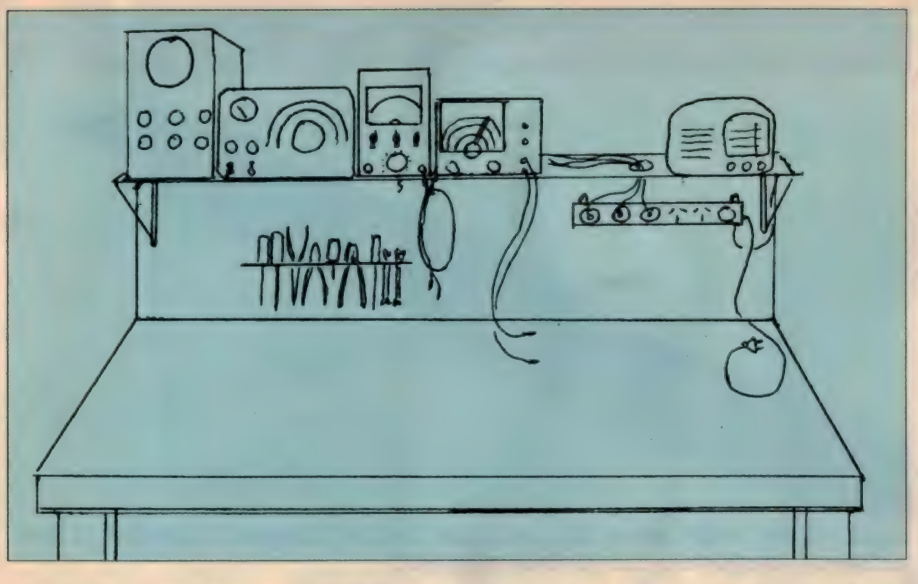


Fig.2: The author's suggested layout for a workbench. Ideally, the bench should be between 1.5 and two metres long.

into a power outlet, either directly or via an extension cord. The problem of sufficient power outlets can often be solved in that way, and a useful layout is suggested in the sketch of Fig.2.

Residual current detectors

The same spokesman from the electrical authority also advised that any alteration to existing wiring, by of course a licensed person, now requires the installation of an RCD or *residual current detector*. These devices are an example of Kirchoff's Law in that they work by detecting the difference, if any, between the current going into any given load and the 'return current' coming out of it. If this variation exceeds 30mA, the device will 'trip' and isolate the AC mains.

One form of RCD is the popular Earth Leakage Detector, in which the current leaking to earth will trip the device. However, there must be an earth for the current to leak, and these devices can be annoying when working with 'AC/DC' or 'universal' receivers, but that will be covered in a future article.

The rationale is that although these devices do have their critics, a person's life (possibly your own) may well be saved as a result of having one installed. Therefore any small annoyances are surely of minor consideration.

Equipment safety

In many ways it was the radio shown in Fig.3 that prompted this article. I want to look at it in more detail, because this will give me the opportunity to talk about well intentioned but ill-informed people and the risks they can run — even by plugging in equipment in this kind of condition.

Look closely at the power plug in Fig.4. This old type of plug is downright dangerous, and nowdays if you find one on anything it should be discarded immediately. The bakelite rim cracks and chips away, exposing the connecting screw. There needs to be only one strand of the multi-stranded conductor poking out a fraction of an inch for some unsuspecting person to get a 'belt'.

Look now at the power flex, in Fig.5. The decayed insulation was marginally retracted for the purposes of the photograph. It goes without saying that this flex is liable to give a person a full 240V shock, or otherwise become the cause of a short circuit. Hopefully the latter would produce only a blown fuse, although more serious trouble can occur.

The radio itself (Fig.3) is also a haven for trouble. A combination of decaying insulation, moisture, dust and time is a recipe for an internal short circuit in the power transformer. Component failure, particularly capacitors, can provide a low resistance path to earth in the rectified HT circuit — seriously overloading, and often burning out, the power transformer.

In the case of a faulty radio the most likely scenario will be a blown fuse. There is often much heat and smoke associated with faulty equipment, and quick action will save damage to the electrical wiring. Most people, now matter how naive in these matters, do have enough sense to turn anything off that is sizzling, sparking or smoking.

If you are inexperienced in these matters, seek advice from a competent person. An electrical repair shop will very likely venture an opinion about the electrical safety, and a technician or radio amateur should help with the rest. Someone in a radio club or society, e.g. the Historical Radio Society of Australia or Wireless Institute of Australia (or their overseas equivalents where applicable) would very likely be able to assist.

Fig.3: Radios in this kind of condition are often plugged in to 'see if they work'. This is fraught with danger, for reasons explained in the text.

NOTES & ERRATA

PC Bus Sleuth (October 1996): Supply bypass capacitor C4 (10nF monolithic) was erroneously omitted from the parts list, while tantalum capacitor C1 was listed as 4.7uF, instead of 10uF as shown in the circuit and overlay diagrams. (Note that the value of C1 is not at all critical, and any value in the range of 2.2uF to 10uF will do.) ❖

VINTAGE RADIO

Fig.5: An old style power flex with this kind of decayed insulation is also extremely dangerous, for obvious reasons.

Fig.4: Old bakelite power plugs like this should be discarded without a second thought. They are dangerous in the extreme, and may be potentially lethal.

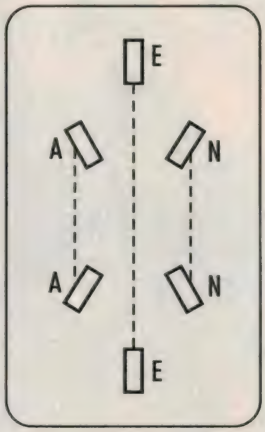


Fig.3: This old style of double adaptor with 'mirror image' outlets is now illegal, as well as being very dangerous. The internal connections are shown in broken lines, which means that one outlet has reversed active and neutral connections.

Double adaptors

You should be aware that the old style of double adaptor shown in Fig.6 are now banned. They effectively reverse active and neutral, for one of the outlets. Look at it closely and figure it out for yourself. If you have one, throw it out. The ones that can be purchased new are the correct type.

One of these old-style double adaptors caused a full 240 volt electric shock to one person some 15 years ago. Here is a first-hand description of the effect:

"I don't know how it happened. I had my hand on the chassis, holding it in place. The soldering iron had been just turned on, was not hot and for some reason I touched it."

"The effect was as though two strong men simultaneously and severly yanked my outstretched arms, and at the same time I was whacked across the chest with a baseball bat. The resulting convulsion threw me off the stool, and I landed on the base of the vertebral column, which in itself was painful and another injury."

"I was completely disoriented for what seemed an eternity (but was probably only a few seconds). Then the pain through my arms and chest, and over my heart in particular was very, very severe, and slowly subsided over an hour or so."

"I was quite weak and lethargic. I suppose they call that physical shock. I recovered overnight."

That person lived to tell the tale. Many, many others have been less fortunate. 240V AC can easily kill you. It is not worth the risk.

By the way, you can be absolutely sure that the story quoted is true, because it happened to the author. ❖

SHORTWAVE LISTENING

with Arthur Cushen, MBE

German Radio continues to expand

The transmissions of Deutsche Welle, which are well received in the South Pacific, continue to expand with the leasing of an old site and the upgrading of the new Wertachtal site, which now has sixteen 500kW transmitters.

Going back in history, one can recall the broadcasts of Germany Calling in the late 1930's from Zessen. After World War II the shortwave service from Germany was silenced until 1952, when two 100kW transmitters were installed at Julich. According to a 1952 report the new transmitters would radiate the 'Deutsche Welle' programme of the broadcasting corporation of Western Germany at Cologne.

This report of some 45 years ago indicated that these were the most modern transmitters of their type. Over the years the Julich site has been upgraded and now houses twelve 100kW transmitters which are now being leased to various organisations.

In September five transmitters were used to carry the All Ireland Finals of football, and from October they are being used by Adventist World Radio for a service to the Balkans, while they have also been observed carrying programmes from Lithuania from this site.

The concentration of high powered transmitters from Wertachtal also meant that the relay station on Malta has closed. This leaves Deutsche Welle with relay points at Kigali, Rwanda, Antigua and Sri Lanka, while facilities of Radio Canada International Radio Brazil and transmitters in the CIS are also used.

Adventist World Radio is using the Julich transmitters 0400-0500 and 1300-1700 on 5905kHz. There are plans for further expansion of this site.

Deutsche Welle broadcasts to the Pacific in English 0900-0950 on 6160kHz, 11,730kHz, 12,055kHz, 17,715kHz and 21680kHz, and 2100-2150 on 7115kHz, 9670kHz, 9765 and 11785kHz. Their address is PO Box 100 444, 50968 Cologne Germany.

Anguilla on shortwave

The island of Anguilla is a newcomer to shortwave broadcasting, although listeners in the Pacific have heard the medium wave outlet on 1610kHz with the slogan of Caribbean Beacon, and at times the alternative channel of 690kHz has been heard. Caribbean Beacon on 1610kHz has a power of 200kW and broadcasts from the capital The Valley.

Anguilla is in the Eastern Caribbean and has a population of 7000. The island was a former British Colony and became a republic in 1980. It is a famous tourist attraction, with its white coral sand beaches.

The Caribbean Beacon has now moved into shortwave with a 100kW transmitter, which has recently undergone tests. Two frequencies have been used, 6090 and 11,775kHz, and it has also registered several other frequencies with the ITU.

Although the transmitter was installed a year ago, there was concern over the radiation from the 100kW transmitter and recently BBC engineers have been on the island taking readings. Once the Anguilla government clears the station for operation and finds the BBC report acceptable, it will be in full service.

The station will carry the University Network programmes with Dr Gene Scott, and will broadcast 24 hours a day. There will be no local programmes. The aerial will be a log-periodic, beamed towards the United States and Canada.

The station address is The Caribbean Beacon, Box 690, Anguilla, BWI.

Pioneer listener

From time to time mail is received from listeners who have recollections of their first radio listening. One of these is Mr Albert Collins, who now lives in Reefton, New Zealand.

Mr Collins' first radio signals were heard at a garage in Temuka operated by Huttons and this was believed to be the first receiver in the town, around the mid 1920's. When the receiver was turned on, crowds would gather on the footpath.

The *Timaru Herald* reported that music and speech could be heard 12 feet away, and the most popular signal around dusk was KFI, Los Angeles, 640kHz which closed down at 8pm each evening with a familiar theme tune and closing announcement, which always included the number of days they had been broadcasting.

In the early 1930's, by diligently saving his money as an office boy, Mr Collins bought a battery receiver which had three tuning dials. These were each scaled 0-100 and it was necessary to get all three dials on the same number in order to hear a signal.

Some 10 years later saw him in North Africa, attached to a small engineers unit. The unit was in the Western Desert, and when next in Cairo they pooled their money and bought a Zenith receiver. This enabled them to listen to the BBC, while the programmes from Berlin often contained some excellent music.

It is interesting to hear from listeners who have memories of early radio. Here in New Zealand with few of our own stations operating, signals from North America on the broadcast band were heard each evening. ❖

AROUND THE WORLD

CROATIA: Radio Croatia International, Zagreb, has sent a complete schedule by registered airmail containing 12 pages and broadcasts. News is broadcast in English daily 0005, 0805, 1005, 1405 and 2005; it beams to Australia 0600-1000 on 7165kHz and 13,830kHz, and to Europe 1600-0700 on 5895kHz, 0700-1600 on 5920kHz, 0600-2300 on 7165kHz and 0600-1230 on 9830kHz.

ITALY: Italian Radio Relay Service, Milan is broadcasting 2100-2300, 0600-0830 and 1430-2000 on 3955kHz; also 0830-1430 on 7125kHz. The power is 10kW, effective to March 30, 1997.

NEW ZEALAND: RNZI Wellington's schedule from 5 October to 16 March 1997 is 1650 on 9875kHz; 1953 on 11,735kHz; 2135 on 15,115kHz; 0458 on 11,905kHz and 0816-1206UTC on 9700kHz. The schedule varies at weekends.

SAIPAN: KHBI has broadcasts to the South Pacific 0800-0900 on 9845kHz; 0900-1000 on 13,840kHz; 1200-1300 on 9430kHz; 1400-1600 on 12,160kHz; 2000-2200 on 13,840kHz and 2300-2400UTC on 13,625kHz.

SAO TOME: VOA is now in operation with 100kW on 4750kHz, with English 0300-0330 and 1930-2030. There are other languages on the transmission.

USA: Radio Marti's latest schedule in Spanish to Cuba is 0000-0400 on 7365kHz; 0400-0600 on 6030kHz; 0300-0500 on 7405kHz; 0600-1200 on 6030kHz; 0900-1200 on 5890kHz; 1200-1400 on 9565kHz, 7405kHz; 1400-1700 on 11,815kHz, 13,820kHz; 1400-2300 on 11,930kHz; 1700-2200 on 9825kHz; 1700-2400 on 13,820kHz; 2200-2400 on 15,330kHz; and 2300-2400UTC on 6030kHz.

WEWN, Birmingham, Alabama on 6890kHz is heard at 0500 in Spanish, then English from 0600 to signoff at 0800, also in parallel with 7425kHz. ❖

This item was contributed by Arthur Cushen, 212 Earn Street, Invercargill, New Zealand who would be pleased to supply additional information on medium and shortwave listening. All times are quoted in UTC (GMT) which is 11 hours behind Australian Eastern Standard Time and 13 hours behind New Zealand Standard Time.

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50 and 25 years ago...

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to 'Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Here we feature some items from past issues.

December 1946

Experimental FM Transmissions: We have progressed a big step towards the next radio innovation — that of FM transmission. The proposed experimental stations to be erected in the capital cities are on the way. FM has to some extent affected the sale and demand for big sets — both manufacturers and consumers are inclined to tread warily until they see just how this matter will develop. It is now generally agreed that FM will not be rushed, and that present transmitters and receivers will be operated for many years to come.

Australian Radar: News of the overseas installation of an Australian designed multiple track radar for aircraft landing is a matter of pride on the part of Australian scientists. It may not be quite true, as indicated in some press reports, that Australia led the world in radar development during the war. But it is true that we had a band of scientists and engineers who were as well informed as any in technical matters, and able to produce radar equipment equal in performance and specifications to that made elsewhere. Australia is well suited to the use of radar navigational aids, and we are certain to see many types developed and used in the future.

December 1971

Smallest 1F Capacitor: At the 1971 Hanover Fair, Siemens displayed a one farad capacitor, weighing only 610g, with a diameter of 6.5cm and a length of 11.5cm. New techniques suitable for mass production were used in making the capacitor. An active area of more than 100 sq cm was obtained by roughening the surface of the metal foil by an electro-mechanical etching process.

Automation in TAB: Amalgamated Wireless (A'sia) Ltd is supplying a number of branch input devices and telephone selling machines to the NSW Totalisator Agency Board under a $3 million contract. The first of the branch input devices is now in operation at the William Street, Sydney, branch. With the new TAB system, less than three seconds elapse from the time a bet is recorded on the machine until a ticket is issued. This includes the time to transmit the data to a central computer, computer processing and transmission back to the operator.

Tracking Station Contract: Standard Telephones & Cables Pty Ltd has been awarded a further contract, with an estimated value of $3 million, for the operation and maintenance of the Honeysuckle Creek tracking station in the ACT. STC has had the contract since the station was opened in March 1967. The new contract is from January 1, 1972 to May 31, 1974. Honeysuckle Creek is one of three prime Apollo stations for manned lunar landing activities, and is part of the manned space flight network managed by NASA's Goddard Space Flight Centre. ❖

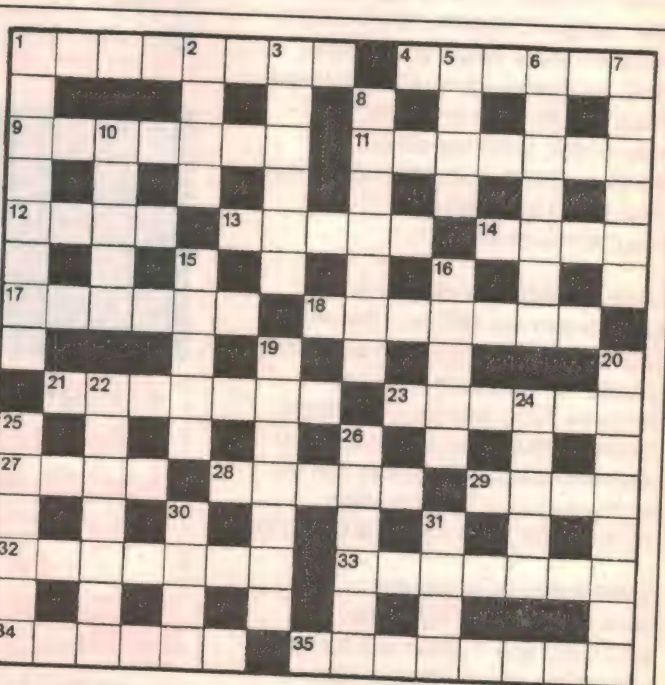
EA CROSSWORD

ACROSS

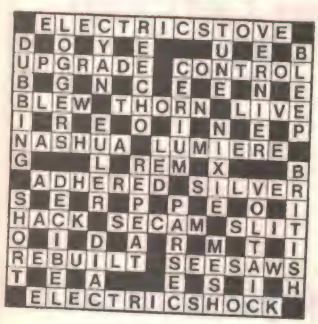
1 Microwave valve. (8)
4 Kind of speaker. (6)
9 Permit. (7)
11 Introduced an operation from keyboard. (7)
12 Very long baseline interferometry. (1,1,1,1)
13 Entry in a truth table. (5)
14 Dynamic random access memory. (4)
17 Homophone of 'last in, last out' is to go to ground! (3,3)
18 Controls. (7)
21 Unit of high resistance. (7)
23 Spikes, surges, etc. (6)
27 Animals capable of giving discharge. (4)
28 Given name of Maxwell. (5)
29 Trigonometric ratio. (4)
32 Moment in time. (7)
33 Famous French physicist (7)
34 Type of transistor. (6)
35 Co-discoverer of the Heaviside layer. (8)

DOWN

1 Large unit of potential. (8)
2 Shade. (4)
3 Directional factor of a rectifier. (3,3)
5 Prefix indicating light sensitivity. (4)
6 Programming language. (7)
7 Housing on an aircraft. (6)
8 Swedish astronomer (1701-44) remembered for temperature measurement. (7)
10 Message form of last century. (5)
15 Computer language. (5)
16 Play a stringed instrument. (5)
19 Act as go-between. (7)
20 Act of construction. (8)
22 Responds to ad for Navy technicians. (7)
24 Brand of timer. (5)
25 Element first discovered in the Sun. (6)
26 Tradename of teletext network. (6)
30 Recording medium. (4)
31 Operation of rocket engine. (4) ❖



SOLUTION TO NOVEMBER 1996:



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TOSHIBA RELEASES FIRST DVD PLAYER, ROM DRIVE & MPEG-2 VIDEO DECODER CARD FOR PC'S

DSTO & CSIRO TO USE GROUND PROBING RADAR TO HELP LOCATE LAND MINES

REVIEW OF AVCOM'S PSA-37D 4.2GHZ SPECTRUM ANALYSER

SPECIAL FEATURE ON MODEMS AND DATA COMMS PRODUCTS

BARCO'S NEW 21" 'PERSONAL CALIBRATOR' MONITOR FOR COMPUTERS: 24-BIT COLOUR, 1600 x 1280 RESOLUTION AND EASY RE-CALIBRATION AT ANY TIME USING BARCO'S PROPRIETARY SOFTWARE & A THIRD-PARTY COLORIMETER...

NEWS HIGHLIGHTS

MITEC WINS $2.6M SAT COMMS CONTRACT

Queensland based Australian firm MITEC Ltd has signed a contract with the Australian Defence Force Material Division worth over $2.6 million, for the supply of three 'fly-away' satellite communications systems to support the Australian Defence Force in its overseas operations. These systems will cover both of the standard commercial satellite communications bands, and have been specified to operate with the world-wide Intelsat network of satellites. All systems will have the ability to support video-conferencing, voice, data and fax applications simultaneously.

The majority of the electronic subsystems required are designed and manufactured by MITEC at their Brisbane engineering and manufacturing facility. All of the systems engineering and project management required will also be carried out by MITEC. This has led to high Australian content in the systems, and will also result in local technical support throughout the expected operational life of the equipment.

MITEC's managing director Dr John Ness said "It is very gratifying to win this work on a competitive tender basis as the prime contractor. We are proud to be supplying equipment for the satellites as well as the earth stations which the ADF wili use." MITEC has just completed a $4.5 million contract with Lockheed Martin, of New Jersey USA, for the design, manufacture and supply of master oscillators which will be used in the Intelsat VIII satellites due to be launched early next year.

MITEC's activities are mainly based on microwave engineering and manufacturing, which forms a key part of many communication and radar systems. The company employs over 150 people in its purpose-built facility, and is a significant exporter of high technology products and services to other countries.

TOSHIBA RELEASES DVD PLAYER, ROM & DECODER

Toshiba Corporation has announced a DVD product line-up targeted at both the home entertainment and computer markets. The company has introduced to the Japanese market its first DVD-Video player (SD3000) and DVD-ROM drive (SD-M1002), as well as a DVD decoder board (IPC0101A) incorporating an MPEG2 decoder that allows playback of DVD video entertainment software on DVD-ready personal computers.

Toshiba has played a central role in developing DVD and defining the DVD format standard. Key DVD technologies developed by the company include short-wavelength semiconductor laser diodes, high-density back-to-back bonded optical discs, and real-time video encoding systems. These capabilities have assured early product availability.

DVD, a next generation multimedia optical disc technology, offers a number of powerful features:

1. A massive 4.7GB of data on a single 120mm-diameter optical disc — the equivalent of 3200 floppy disks, seven CD-ROMs, or a full-length feature movie.
2. A single file format integrating images, audio and computer data on a single medium.
3. Compatibility with today's CDs and tomorrow's rewritable DVD.
4. Superior picture and sound quality, through MPEG2 digital image compression and Dolby Digital (AC-3) 5.1 channel surround sound.

A surge in interest in DVD is now expected, and worldwide demand for DVD-related hardware, including ROM and RAM drives and video players, is expected to reach 120 million units in 2000.

TINY LOW POWER FLASH CARDS FOR CONSUMER MKT

Semiconductor firm AMD has announced sample availability of business card-sized, removable flash memory cards for consumer electronics such as digital cameras, audio recorders, smart cellular phones and pocket PCs. Based on the Miniature Card standard, which is endorsed by 38 leading high technology and consumer electronics companies including Sony, Hewlett-Packard, Philips, Olympus, Nokia and Konica, the cards have the ability to store and exchange image, text and voice data.

"As the market for digital handheld consumer devices grows, so do the requirements for consumer-friendly, cost-effective removable media", said Walid Maghribi, vice president and general manager of AMD's Non-Volatile Memory Division. "We believe our

flash technology advantages, combined with the features and capabilities of our new Miniature Card, make AMD the vendor of choice for low-power and portable system designs."

According to AMD estimates, the small form-factor removable memory card market will grow to over 50% of the total flash card market in the year 2000. In-Stat market forecasters estimate the flash card market will exceed US$1 billion by the year 2000.

The new AMD cards are based on AMD's Am29LV080 (2.7V) and Am29F016 (5V) flash memory chips, and will be offered in 2MB and 4MB densities initially.

AWARD FOR NASA'S 'THUNDER' TECHNOLOGY

A NASA technology that could make everything from audio speakers to heart pumps smaller and more efficient has been recognised as one of the 100 most significant technological advancements of the past year.

Dubbed THUNDER, for Thin-Layer Composite-Unimorph Piezoelectric Driver and Sensor, the technology's potential applications could be applied in electronics, optics, jitter (irregular motion) suppression, noise cancellation, pumps, valves and a variety of other fields.

Researchers at NASA's Langley Research Center, in Hampton, Virginia, have taken advantage of a well-known phenomenon exhibited by piezoelectric materials. These materials generate mechanical movement when subjected to an electric current, as in a speaker or actuator, and generate electrical charge in response to mechanical stress, as in certain types of sensors.

The Langley researchers, a multi-disciplinary materials integration team, succeeded in developing and demonstrating a piezoelectric material that is superior to commercially available piezoelectric materials in several significant ways. It is tougher, more durable, allows lower voltage operation, has greater mechanical load capacity, can be easily produced at a relatively low cost and lends itself well to mass production.

The first generation of THUNDER devices are being fabricated in the lab by building up layers of commercially available ceramic wafers. The layers are bonded using a Langley-developed polymer adhesive. The process results in a pre-stressed device with significantly improved performance. In addition, the process is controllable and results in highly uniform pieces of hardware.

In the ideal fabrication process — which researchers believe is technically feasible — piezoelectric ceramic materials would be ground to a powder, processed and blended with an adhesive before being pressed, molded or extruded into wafer form. The result would be increased ability to tailor properties, more flexibility in choosing methods of manufacturing and increased amenability toward mass production.

THUNDER wafers could be any practical size from areas of a few square millimetres to several square metres, with thicknesses of fractional millimetres to several millimetres.

Shaffner's BEST 96 is a complete EMC testing system in a compact package, designed to allow full EU compliance testing of electrical and electronic projects (to EN 50082-1). In Australia it's available from Westinghouse Industrial Products, in South Melbourne — phone (03) 9676 8888 or fax (03) 9676 8702.

FLUKE RELEASES MULTIFUNCTION COUNTER

Many users find conventional digital counters and timer/counters difficult to operate. This results in operation errors and a lack of confidence and effectiveness for occasional use in general purpose measurements. A particular problem is that a counter is a 'blind' instrument, displaying a numeric value without any indication of whether settings like triggering have been optimised.

A new generation of MultiFunction Counters from Fluke are designed to solve these problems. A built-in waveform display plus a 'smart', user-friendly interface is claimed to provide detailed information combined with intuitive operation and context sensitive support.

The new Fluke 160 MultiFunction Counter is an accurate handheld Timer/Counter that can also measure wideband voltages and displays the waveform of the input signal up to 50MHz. The modern user interface is very easy to operate. Settings and readings are displayed on a bright high-contrast 240 x 240 pixel LCD panel. Moreover the instrument has a built-in context sensitive help function, and even includes a tutorial for the first-time user. Operation is highly automated via a signal-adaptive Autoset function. Selection of measuring functions and trigger settings is menu controlled, using a Windows-like user interface.

CSIRO marine electronics specialist David Edwards (a former EA staff member) closing the nose cone of TASITA, a torpedo-like sensing unit used to monitor ocean surface temperature. It incorporates two DT500 Datataker loggers made in Australia by Victorian firm Data Electronics.

SIMOCO TAKES OVER PHILIPS MOBILE RADIO

One of the largest radio communications companies in Australia, SIMOCO Pacific, has been created after the takeover of the private mobile radio business of electronics giant Philips. The transfer is part of the worldwide acquisition of Philips Telecom Private Mobile Radio by UK-based SIMOCO International Limited.

SIMOCO (from 'Systems Integrated Mobile COmmunications') was launched earlier this year by CINVen, a leading venture capital group that invests some £2 billion for its key institutional clients, including British Coal, Barclays Bank Pension Fund and Royal Insurance.

SIMOCO has chosen Australia as the regional headquarters for its Asia Pacific operation, which takes in offices and dealer networks throughout Australia as well as Taiwan, Indonesia, Malaysia, Thailand, Hong Kong, Singapore and New Zealand.

The executive chairman of SIMOCO International is Ian McKenzie, an Australian who was general manager of Philips Communications in Australia and later managing director of the international Philips Private Mobile Radio (PMR) business.

"We believe we have an outstanding base in the Pacific from which to launch new products and services", Mr McKenzie said in Sydney recently. "The maturity of the market in Australia, the time zone and ease of access to south-east Asia and the Pacific for the provision of all aspects of customer service, make this country an ideal location for a regional headquarters."

Mr McKenzie said a range of new digital radio products, based on the international TETRA standard, would be released by SIMOCO from next year.

"We are committed to maintaining a leading position in the development of the TETRA digital mobile radio standard in Australia."

1996 ATERB MEDAL WINNER

The Australian Telecommunications and Electronics Research Board has awarded its Outstanding Young Investigator Medal 1996 to Dr Vikram Krishnamurthy, a brilliant young theoretician who by age 30 years has already achieved an enviable research career. He specialises in the application of Hidden Markov Models to non-linear estimation theory.

Dr Krishnamurthy's internationally recognised work in this field is providing the theoretical foundations for future communications systems. It is expected to lead to new and more efficient reception techniques, and channel parameter estimation techniques enabling the optimal choice of protocols.

However his work also has application in many other fields, some quite surprising given its origins. Outside the more traditional communications areas Dr Krishnamurthy's contributions are finding use in radar identification, interference suppression in Personal Communication Systems (PCS) and speech coding. More unusual outlets include modeling of market cycles in econometrics, and neuro-biological signal processing to help explain the mechanisms for nerve impulses propagating through cell membranes. The latter is of significance in understanding several neurological and muscular disorders.

The Australian Telecommunications and Electronics Research Board is jointly sponsored by Telstra, CSIRO and DSTO.

CHURCHILL FELLOWSHIPS

One hundred and eleven fortunate Australians are preparing to go overseas on their 1997 Churchill Fellowships. Churchill Fellowships are available to all Australians, from any walk of life, who wish to go overseas to improve skills or undertake an investigative study where the opportunities overseas are not fully available in Australia.

Churchill Fellowships last about three months and air fares, fees and a living allowance are paid. The average value of a Churchill Fellowship will be about $15,000.

Applications opened on 1 November and close on 28 February 1997. For an Information Booklet and application forms send a stamped self-addressed envelope (approx. 24xl2cm) to:

Application Forms,
The Winston Churchill Memorial Trust
218 Northbourne Avenue,
BRADDON ACT 2612

The Information Booklet is also available on the Internet World Wide Web at **http://cibc.anutech.com.au/new/134**.

GROUND PROBING RADAR HELPS FIND LANDMINES

Australia's DSTO is working with CSIRO on a state-of-the-art ground probing imaging system that can distinguish between a land mine and shrapnel.

Dr David Heilbronn, of DSTO's Microwave Radar Division, says the Ground Probing Radar (GPR) technology holds the most promise for bringing about a dramatic reduction in the time needed for mine clearance. Australia is a major

contributor to the Cambodian Mine Action Centre through which about 1500 trained de-miners are on active duty.

However it is estimated that between two and 10 million mines are currently sown in Cambodia and at the current clearance rate will take 200 years.

Dr Heilbronn said that the major difficulty for the de-miners was that the main detection device was a metal detector but the majority of the mines had low metal content. The situation was made difficult by the large amount of shrapnel scattered in the mine fields.

"In fact some 10,000 pieces of shrapnel are removed for each mine that is found", he said. "As the existing detectors cannot distinguish shrapnel from landmines, every piece of shrapnel has to be removed."

This meant that some 50 billion pieces of shrapnel would have to be removed, all with the same care as a mine.

The CSIRO device uses a sufficiently low frequency impulse so that the wave can penetrate through the ground.

DSTO is now cooperating with CSIRO to modify the antennas of the FR127 radar to null the reflection from the surface of the ground so that small, shallow buried mines can be detected.

"It is recognised that there is no one silver bullet to solve the detection problem, and that a combination of sensors will give the best results," Dr Heilbronn added.

CSIRO is now seeking a commercial partner to combine the GPR with an improved metal detector in the one unit and to automatically fuse the data from both sensors.

SMALL BUSINESS DEREG TASK FORCE

The federal government has established a task force to address the regulatory burden on small business. It has been specifically charged with reporting on revenue-neutral ways of reducing the regulatory burden on small business, by 50%.

The task force is chaired by Mr Charlie Bell, Managing Director of McDonald's Australia, and it has five other members from small business, plus a government representative.

Meetings with small business and industry groups have been held in all state capitals (except Darwin) and a large number of submissions have been received. The task force was to report its findings and recommendations to the government on 1 November.

Matters taken into consideration by the task force include the paperwork burden from government statistical collection, taxation paperwork, federal regulation and its interaction with regulation by state and local governments.

A number of research findings have already been released by the task force as a result of independent studies which it commissioned. The studies included an analysis of perceptions in small business about regulation and compliance paperwork. This showed that small business felt beseiged and found that the psychological impact cannot be overestimated.

The task force can be contacted by phoning (06) 279 7261. Information is also available on the Web at **http://www.dist.gov.au/smallbus/-sbtf.html**.

Haven Electronics of Nowra, on the southcoast of NSW, has again won the Jaycar Electronics 'dealer of the year' award. Pictured are Haven sales staff Ilsa Hansen, Bernadette Hughs, Norm Day and Darren Lester. Haven is located at Shop 1, 90 Worrigee Street.

NEWS BRIEFS

- Mr Les Bennett has been appointed manager of the Queensland office of Megatec.
- SGS-Thomson has appointed Veltek as distributors for its entire range of semiconductor and module products.
- The 1997 Australasian Cable & Satellite Television Conference and Exhibition will be held at the Sydney Exhibition and Convention Centre at Darling Harbour, February 4-6 1997. For details phone (02) 9210 5700.
- International Rectifier has appointed Zatek as the company's Australian distributor and representative.
- The inaugural Telebusiness Expo will be held at the Hilton Hotel, Sydney, March 11-13 1997. For details phone (02) 9210 5700.
- Indium Corporation of America has appointed Mr Steve Lawrence as director, Asian Pacific Operations. ❖

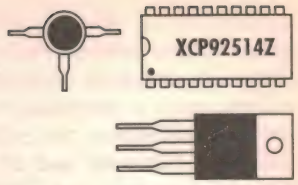
TOSHIBA DEVELOPS BLUE-PURPLE LASER

Researchers at Toshiba's Research & Development Centre in Tokyo have succeeded in developing a blue-purple semiconductor laser that emits a pulsed laser beam with a wavelength of 417nm (nanometres) at room temperature. The prototype semiconductor laser, which uses a gallium-nitride compound as its basic material, is a key step toward realizing a laser offering the short-wavelength, high-power and continuous-wave operation required for future generations of DVD technologies.

Two breakthroughs allowed realisation of the blue-purple laser emission. First was success in fabricating very thin layers of GaN compound crystals in a multiquantum-well structure. The thin layers were achieved using Toshiba's metal-organic chemical vapour deposition (MOCVD) technology.

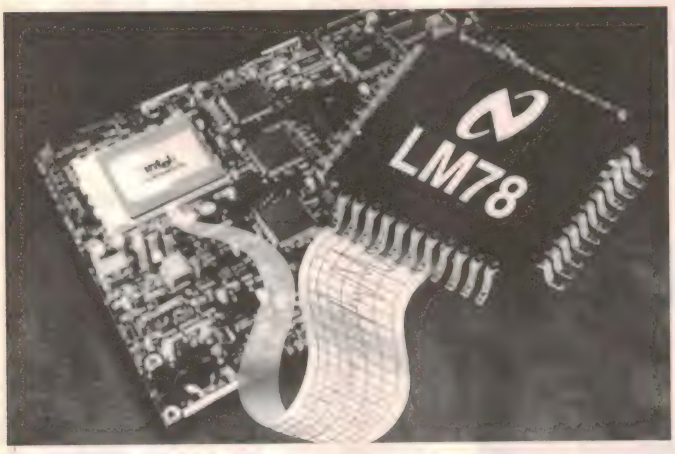
The second breakthrough came in a new technology for cleaving the GaN crystal grown on a C-face sapphire substrate and assuring a smooth surface. ❖

Solid State Update



KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

Monitor for micro systems



National Semiconductor has added a new IC to its temperature-sensing family of devices. The device, type LM78, monitors potentially hazardous, user-defined conditions within microprocessor-based systems. It combines key analog and digital monitoring functions, including temperature, voltage, fan speed and many key digital system signatures. It can communicate error conditions via an I²C or ISA interface, and generate interrupts based on user-defined and programmed limits for key parameters.

The device can be used to set hazard warning limits via watchdog registers for most key analog functions within a PC/server environment, enabling interrupts to be set based on the performance of system functions. Key features include: +/-3°C temperature accuracy, user-programmable watchdog limits register for over-temperature, seven voltage monitoring analog inputs, three fan inputs (including two user-programmable inputs for speeds ranging from 1100rpm to 8800rpm) and a board temperature interrupt input.

The IC has an 8-bit Delta-Sigma A/D converter with a seven input MUX for high noise immunity in microprocessor environments. Also included are inverting op-amps for measuring negative power supplies. An on-board 32-bit POST RAM allows the device to be among the first devices to be activated, so it can record the performance of other system parts during system boot-up.

National has a computer-based application board to evaluate the device's characteristics.

For further information circle 274 on the reader service coupon or contact National Semiconductor, Business Park Drive, Monash Business Park, Notting Hill 3168; phone (03) 9558 9999.

Video op-amp has 100MHz BW

Analog Devices' new AD8072 (dual) and AD8073 (triple) current feedback video amplifiers feature 0.05% differential gain and 0.1° differential phase error. They are available in 8-pin and 14-pin narrow body SOIC packages respectively, and are claimed to replace equivalent video amplifier circuits consisting of up to 25 discrete components. They have a 100MHz bandwidth (-3dB) or 10MHz (0.1dB), a 500V/us slew rate, and a 20ns settling time to within 0.1%. The amps can operate from either a dual +/-5V or a single +5V supply and take less than 5mA. They are optimised to drive 150Ω loads for standard RGB, YUV and S-Video signals.

Typical applications include TV set-top boxes, computer VGA plug-in cards, MPEG video systems, and video games.

For further information circle 276 on the reader service coupon or contact Analog Devices, PO Box 98, West Rosebud 3940; phone (059) 86 7755.

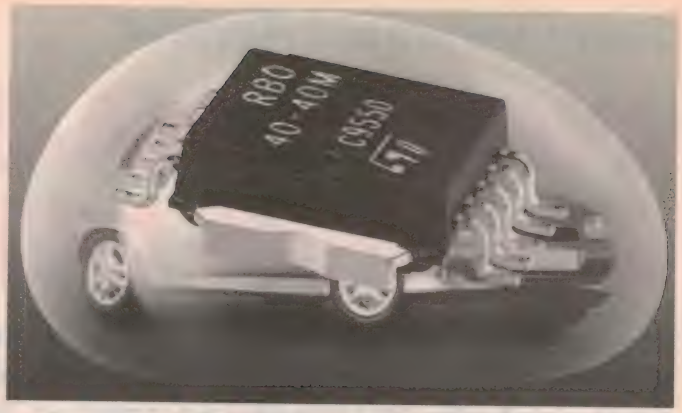
Surface mount audio transducers

Philips now stocks a range of surface mount audio transducers, buzzers and audio indicators. Made by Projects Unlimited Inc, of Ohio USA, the range comprises 23 different models, with more planned. Included are piezo-ceramic and electromechanical transducers, electromechanical buzzers and piezo-ceramic indicators (which include a drive circuit).

The devices have a frequency range from 2300Hz to 4000Hz, and operate with voltages from 1.5V DC to 30Vp-p, and have an audio output up to 102dBA at 100mm. Size is 8.5 x 8.5 x 4.0mm high, and models include sealed and washable versions. Most are available in tubes as well as tape-and-reel.

For further information circle 271 on the reader service coupon or contact Philips Components, 34 Waterloo Road, North Ryde 2113; phone (02) 9805 4479.

SMD automotive protection IC



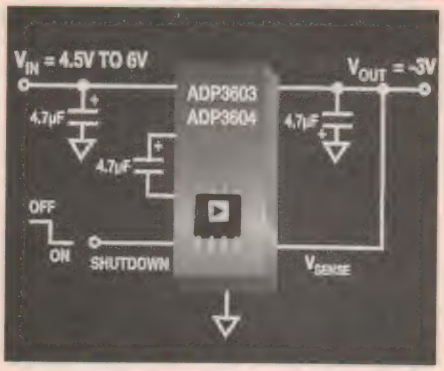
Developed specifically for the automotive market, the RBO40-40M from SGS-Thomson Microelectronics is a surface mount device that protects automotive circuits from reversed battery connection and transient over-voltages. Built with the company's proprietary application specific discrete (ASD) technology, the device can handle an average forward current of 40A and has a maximum clamping voltage of +/-40V.

The IC contains a series diode for reverse battery protection, a bi-directional Transil diode to clamp negative over-voltages and a power Transil that protects against high energy transients that occur when the battery is disconnected while the alternator is running (called a load dump). The IC has a 40ms surge capability to cater for load dumps. Other key features include a peak load dump over-voltage of 80V and a minimum breakdown voltage of 24V, enabling the device to withstand twice the 12V battery voltage — allowing jump starting with two batteries in series.

The device is packaged in a Power SO-10 package, (originally developed by SGS-Thomson), a 10-lead small outline plastic package with an integral metal slug that is compatible with SMT requirements.

For further information circle 279 on the reader service coupon or contact SGS-Thomson Microelectronics, Suite 3, Level 7, 43 Bridge Street Hurstville 2220; phone (02) 9580 3811.

Inverter ICs need no inductor



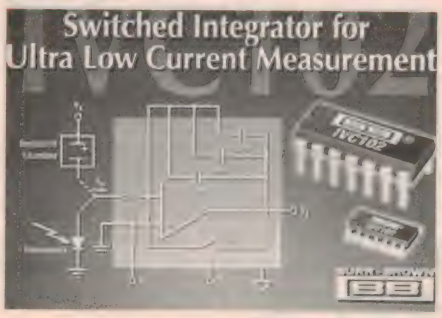
The new ADP3603 and ADP3604 high frequency, switched-capacitor voltage inverters from Analog Devices are claimed to eliminate the need for external inductors. The devices provide up to 50mA and 120mA of output current respectively, with +/-3% output error over their 120kHz output switching frequency. Output ripple is 15mV and 25mV respectively. They can operate with a capacitor as low as 1uF.

The regulators dissipate less than 400mW of power and have a shutdown mode of less than 5ms, which lowers the quiescent current to 1.5mA. Applications include computer peripherals and add-on-cards; portable and battery-powered instrumentation; pagers and radio-controlled receivers; disk drives; mobile phones and other communication devices.

The devices are designed primarily for use as high-frequency voltage inverters and negative voltage regulators. Output is fixed at -3V from an input voltage ranging from +4.5 to +6V. Load regulation is 0.12mV/mA and 0.32mV/mA respectively. Both regulators are available in small outline 8-pin SOICs.

For further information circle 278 on the reader service coupon or contact Analog Devices, PO Box 98, West Rosebud 3940; phone (059) 86 7755.

Integrating op-amp has 0.005% linearity



Burr-Brown has released the new IVC102, a precision FET-input integrating amplifier with on-chip integration capacitors and low leakage analog switches for converting a low-level input current to an output voltage. The device integrates the input current for a user-determined period, and holds the resulting voltage on the integration capacitor for measurement.

It is claimed to provide an accurate, lower noise alternative to op-amp/resistor transimpedance amplifiers and to be ideal for amplifying low-level sensor currents, as well as for leakage current measurement. Applications include medical diagnostic instruments, industrial measurement, analytical and scientific equipment.

The IC can integrate a positive or negative input current and separate 10pF, 30pF and 60pF integration capacitors can be connected in combinations up to 100pF. External integration capacitors can also be used. TTL/CMOS-compatible timing inputs control the integration period, hold and reset functions.

The input bias current is typically 100fA and the linearity is 0.005%. It is available in 14-pin plastic DIP and SO-14 surface-mount packages, and is specified over the -40°C to +85°C.

For further information circle 275 on the reader service coupon or contact Kenelec, 2 Apollo Court, Blackburn 3130; phone (03) 9878 2700. ❖

Test Instrument Review:

AVCOM'S PSA-37D SPECTRUM ANALYSER

This new wideband spectrum analyser should be of particular interest to satellite system installers, as it covers both the 950 - 1750MHz satellite IF band and the 3.7 - 4.2GHz 'C' band, along with the HF/VHF/UHF spectrum from below 10MHz to 950MHz. It's also portable, with a built-in battery pack to allow operation away from the power mains.

by JIM ROWE

You may not have heard of AVCOM, but they're a test test equipment maker based in Richmond, Virginia (USA). Their new PSA-37D Spectrum Analyser is being distributed in Australia by Peter Lacey Services, of Frankston in Victoria. Regular readers of *EA* will know that Peter Lacey brings in a range of equipment for the TV industry, including pattern generators, spectrum analysers, CATV and MATV distribution amps and antenna systems.

The PSA-37D is a relatively low cost instrument as spectrum analysers go (which is quite high!), intended for general use in radio communications work — but also, and specifically, for use by technicians who install or maintain satellite receiving systems. With these users and uses in mind, it's also designed to be straightforward and convenient to operate. The emphasis is on minimal adjustment time and rapid evaluation of real-world signal conditions, rather than the levels of stability and absolute measurement performance that would be expected in an R&D lab.

Similar in size to a conventional analog bench scope (370 x 340 x 140mm) and weighing less than 8kg complete with its batteries, the PSA-37D is also compact and portable enough to be just as suitable for field work as for use on the bench. The ability to operate from either batteries or mains power clearly also adds a great deal to its flexibility and appeal for field work.

To make it of particular value to people working with satellite receiving systems, the PSA-37D has built-in facilities to supply the usual +18V or +12V DC 'phantom power' to LNBs (low-noise block downconverters), via the IF downlead. This allows it to be used to examine and measure the LNB output directly, without any worries about arranging power from the main receiver. A front-panel switch determines whether the phantom power is +12V, +18V or disabled as desired.

The other main feature of special interest to satellite people is its frequency coverage, which includes the full 950 - 1750MHz 'satellite IF band' as well as the 3.7 - 4.2GHz 'C' band. These bands are in addition to covering the complete HF/VHF/UHF range from below 10MHz to 1GHz. There are two input connectors, by the way, one a type-N socket used for the C band and the other a BNC socket used for all of the other bands. Although not specified, both inputs appear to have an input impedance of 75 ohms and both operate in parallel as far as the phantom LNB powering system is concerned.

The frequency range up to 1750MHz is covered in four 500MHz-wide ranges, with the two lowest ranges used to provide the general coverage to 1GHz. The first covers up to 500MHz, and the second from 500MHz to above 1000MHz. The third range then covers the 'original' satellite IF band, from 950MHz to 1450MHz, while the fourth covers from 1250MHz to 1750MHz. These range limits are all nominal, incidentally — in virtually all cases the actual range extends further at each end, to provide plenty of overlap.

The frequency band in use is selected using a five-position rotary switch at the top right-hand corner of the analyser front panel.

As with many modern spectrum analysers, a digital readout is used to indicate the PSA-37D's centre frequency at any time. In this case the readout is via a four-digit LCD panel, and the rated accuracy is +/-6MHz, at zero display span. Just to the right of the display is a multi-turn rotary control used to adjust the centre frequency.

Another front-panel control allows the span itself to be adjusted to any value between effectively zero (giving a kind of 'S-meter' display at the indicated centre frequency) and the full 500MHz, as desired. A further control allows adjustment of the sweeping rate, from about 2Hz to 30Hz.

The remaining main rotary control is a switch marked 'Reference Level', which adjusts the analyser's input sensitivity in three steps of 20dB. In the '0dB' position the top of the screen represents an input level of 0dBm (+49dBmV), while in the most sensitive '-40dB' position it represents an input level of -40dBm (+9dBmV).

The main display of the analyser is via a CRT, with a diagonal of 120mm. The active area of the graticule measures 98 x 68mm, and is divided into 10 major divisions horizontally and seven vertically. The maximum on-screen dynamic range is rated as 60dB, and the PSA-37D is specified as being able to display signals as small as -90dBm — i.e., about 9uV into 75 ohms.

A small toggle switch marked 'Scale' sets the analyser's vertical display sensitivity to either 10dB or 2dB per major division, with the latter position used to achieve maximum resolution of weak signals. Three further toggle switches control instrument power (Standby/Battery/Line), battery charging (Off/On) and LNB phantom power (Off/+12V/+18V). Indicator LEDs alongside each switch glow in standby mode, when the battery is being charged and when LNB phantom power is connected to the input connectors respectively.

That's just about all of the main controls, apart from two small rotary controls which adjust display brightness and vertical position respectively. The former allows convenient viewing in different ambient lighting conditions,

Comparable in size with a conventional analog scope, the PSA-37D can operate from either the mains or inbuilt batteries — making it very suitable for field use. A padded custom carry case is available.

while the latter is handy for making signal level comparisons at the higher sensitivity settings.

The only other manual control is a 'Battery Monitor' button, which when pressed converts the LCD display into a battery voltmeter. The two remaining controls are recessed and only accessible via an insulated alignment tool. One adjusts horizontal centring (i.e., to set the 'centre frequency' to the exact centre of the display at all span settings), and the other sets the zero for the centre frequency readout. Both of these are set at the factory, and shouldn't need operator adjustment.

Incidentally the PSA-37D is sturdily made and housed in a pressed aluminium case, with solid cast cable storage brackets at the rear which double as feet when the instrument is operated in the vertical position. It comes complete with an Operation Manual, in an A4 ring binder.

A padded custom carry bag is available as an optional extra, fitted with zippered covers at both front and back, and a further zippered compartment on the 'top' surface.

In practice

Peter Lacey Services kindly loaned us a PSA-37D for a while, so we could try its operating convenience in a variety of typical measurement situations. We also took the opportunity to check out some of its basic performance specs — except on the top range, where we didn't have suitable instruments at our disposal.

Looking at the performance first, we found that the working sensitivity easily bettered the rated nominal figure of -90dBm. In fact for a signal producing a peak of approximately double the amplitude of the effective noise 'floor' (our definition of a clearly visible signal), we obtained figures of between 2.5uV and 5uV over the full range covered by our instruments. Over most of the range the figure was fairly constant at 3.5uV, which corresponds to a little above -100dBm.

The indicated centre frequency accuracy on the bottom two ranges was well within the rated +/-6MHz, but was a little outside this tolerance range on each of the two satellite IF ranges. (We couldn't check it on the top range.) The resolution bandwidth appeared to be close to the rated figure of 250kHz, which is a little too wide for design work but probably quite suitable for the intended applications.

Most spectrum analysers exhibit a few internally generated spurious signals, and the PSA-37D is no exception. We detected a modest number of small but significant spurious signals, many of them outside the nominal span of each range but a few inside their spans. For example there were spurious peaks at around 14MHz and 26MHz on the bottom band, at 625.85MHz on the next band, at 1370MHz on the third band and at 1470MHz on the fourth band. However none of these was excessive in amplitude (varying between -75dBm and -90dBm, in the main), and once their existence is known they're unlikely to cause any problems in making practical measurements.

Turning now to the operational side of the PSA-37D, we found it particularly convenient and intuitive to 'drive'. The controls are well laid out, and generally have a very logical feel. The multi-turn centre frequency control allows smooth and convenient setting of any desired frequency, and is well balanced between being too critical and too 'slow'.

We also liked the sensible panel markings for many of the controls, which show suggested 'default' settings. The indicator LEDs on the control switches below the screen are a nice touch, too, and indicate thoughtful design.

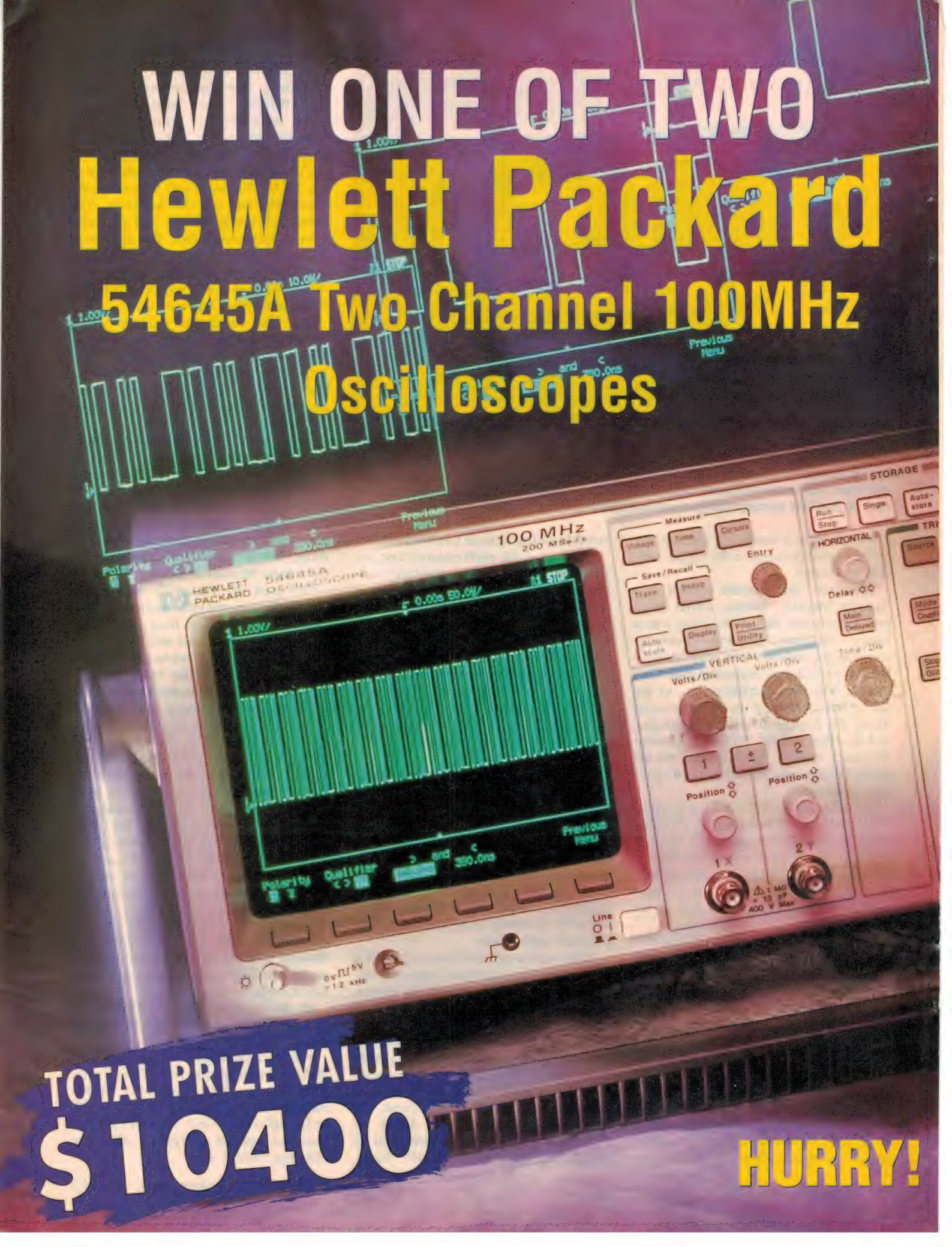
We found the Operation Manual (marked 'Preliminary') a bit spartan, with less information than we expected on the operation of the analyser, its adjustment and maintenance. Perhaps there will be a separate service manual available which covers this sort of thing, but it wasn't mentioned in the Operation Manual itself.

We used the PSA-37D to examine signals from signal generators and wideband noise generators, from a wideband VHF/UHF antenna and also from a Ku-band satellite LNB fitted to a dish aimed at the Optus B1 satellite. In each case it allowed convenient measurement of the amplitude and frequency of the signals of interest, within the limits imposed by its specification. With the signals from the LNB, it was very easy to identify the signals from each of the transponders on the B1 satellite, and to measure their amplitudes in both the horizontal and vertical polarisation modes of the LNB.

Overall, then, our impressions of the AVCOM PSA-37D are that it's a very solid and practical instrument, as well as one that's convenient to use. It should be of considerable interest to anyone looking for a reasonably priced spectrum analyser covering the ranges concerned, quite apart from its intended use by people working on the installation and adjustment of satellite receiving systems.

At the quoted price of $3696 plus sales tax (22%), it also seems quite good value for money.

Further information on the AVCOM PSA-37D is available from Peter Lacey Services, at 80 Dandenong Road, Frankston 3199; phone (03) 9783 2388, or fax (03) 9783 5767. The company has also just opened a Sydney office, in Chipping Norton. ❖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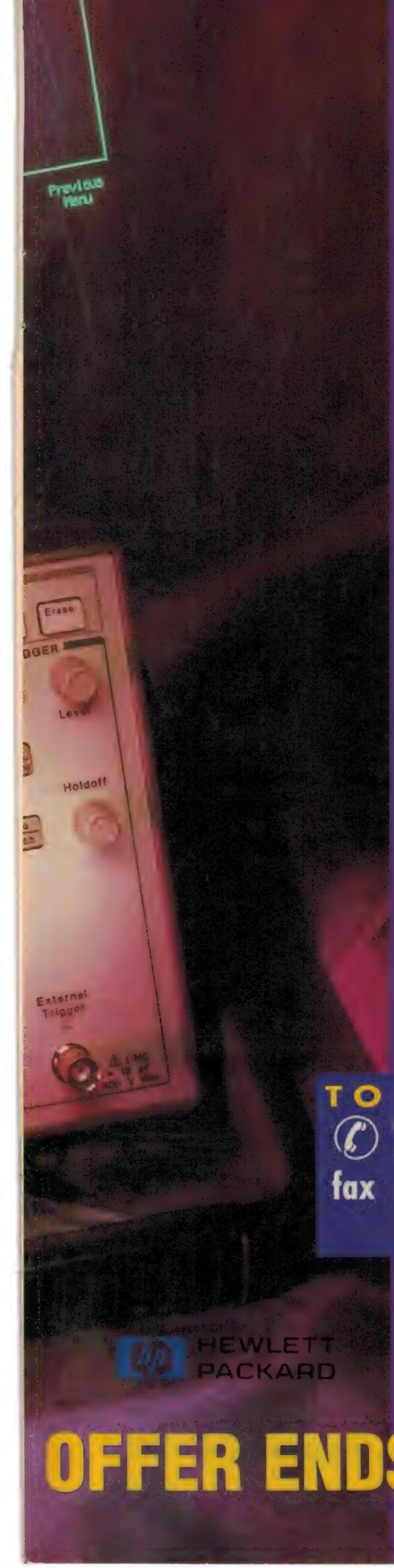

ELECTRONICS AUSTRALIA and *Hewlett Packard* are giving away two HP*54645A Two Channel Oscilloscopes* valued at $5200 each.

To address unmet needs of high speed circuit designers, Hewlett Packard have introduced the *HP 54645A dual-channel oscilloscope* which is the highest performance product in the *HP 54600-series 100MHz* line.

The *HP 54645A* is ideal for the engineer or for anyone who is looking to simplify test procedures and speed up setup with an all-in-one solution.

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Special Feature:

MODEMS AND COMMS PRODUCTS

Server integrates Web access

Stallion Technologies has released a new communications server for local and remote access to TCP/IP-based networks. The new server, called EasyServer II, is claimed to offer the fastest data transmission rates of any server in its class. At under $1900 for a 16-port server, the system is also claimed as the first communications server to provide an integrated Web server.

According to Stallion's vice president of marketing and strategic planning, Mr John Havers, the system will appeal to small to medium-sized corporations, especially those with geographically dispersed operations that need both local and remote access.

The Web server gives access to hyperlinked help pages, a step-by-step tutorial and utility software stored within the server using any standard Web browser. Stallion plans to incorporate full configuration and management software into the Web server, enabling EasyServer to become fully integrated into any corporate intranet.

The server is SNMP MIB II compliant, enabling it to be queried by popular network management platforms such as HP OpenView or IBM NetView for network statistics. It is both self-booting and network-booting, with the ability to automatically download software upgrades into the server across a network.

Remote access features include PPP, SLIP and CSLIP asynchronous Ethernet protocols, PAP authentication, call-back security and multi-level (user, port and server) password security. Havers claims the high network throughput and serial transmission rates of up to 230kb/s provide capacity for the connection of a number of devices such as printers, character and Windows terminals, V.34 modems and ISDN terminal adaptors.

For further information circle 206 on the reader service coupon or contact Stallion Technologies, 33 Woodstock Road, Toowong 4066; phone (07) 3270 4242.

Secure PCMCIA modem

Racal Data Group has introduced a V.34 modem and a security device on a single PCMCIA card. The product, SafeDial V.34, provides PC and mobile computer users with secure data communication and remote local area network (LAN) access over public and private telephone networks.

"The SafeDial V.34 is the most secure PC card encrypting modem available in the world," said Bruce Goldstone, Racal Data Group's Business Development Manager for Asia Pacific.

"It was initially developed for the UK Government and has been certified to the ITSEC standard, which means it has been approved for use in sensitive government applications."

The product is claimed to prevent unauthorised system access and to provide privacy against eavesdropping by encrypting all information between the central site and the remote location. In a portable computer, the card fits into a Type II PCMCIA slot, and connects to a telephone outlet in the usual way. The encryption is activated with a password.

Similarly, at the corporate location, the SafeDial V.34 installs in any remote access server that accepts PCMCIA card modems. After configuration, the product only requires a password (or PIN) for normal operation. Use of Diffie-Hellman public key management and (optional) X.509 certificates on all communications prevents access by unauthorised users to the network. To ensure secure transmissions, SafeDial uses a different and random encryption key each time it is used, making it unnecessary to generate, update and regularly distribute encryption keys.

The SafeDial V.34 uses Flash memory to store program code, allowing upgrades through secure software downloading. This also lets users add new features, encryption algorithms and standards, without hardware replacement. The modem is priced at $1300. For further information circle 202 on the reader service coupon or contact Racal Australia, 3 Powells Road, Brookvale 2100; phone (02) 9936 7000.

RS-232 fibre optic modem

The OSD136 synchronous/asynchronous RS-232 fibre optic modem from Optical Systems Design is a small, self-contained modem that provides full duplex RS-232 communication over distances up to 5km of commonly available multimode optical fibre. Its characteristics of handling clock, data signals and two handshake lines all operating at baud rates up to 20kb/s are derived from its single chip multiplexer. Although it is normally used as an RS-232 modem, the chip allows the unit to be used as a four channel multiplexer. The modem can be set for asynchronous communications for data rates between DC and 20kb/s. In synchronous mode it is operated with an external clock. It is suitable for situations where distance, electrical noise or security considerations make conventional twisted pair links impractical.

For further information circle 203 on the reader service coupon or contact Optical Systems Design, PO Box 891, Mona Vale 2103; phone (02) 9913 8540.

Multi-modem cards

ServerTech has released two new PC add-in cards which host either four or eight separate V.34 BIS 33.6kb/s fax/modems on a single board. According to managing director John Warwick, the two cards represent the first products in the company's plans to develop and manufacture card-based solutions for remote access needs.

The two cards, ServerTech 4 and ServerTech 8, work on a wide variety of platforms and hardware, provided they have an ISA bus. It's claimed that up to eight cards can be fitted in a single server, allowing up to 64 ports.

The cards work with Windows NT, SCO-Unix and other Unix based systems, without a driver, and have a high level of remote control. Future products in the ServerTech line will concentrate on providing card-based solutions for creating communications servers, whether analog, Frame Relay or ISDN.

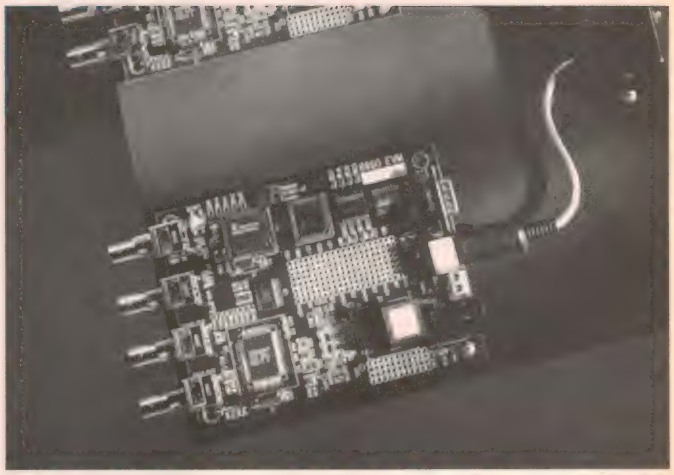
For further information circle 201 on the reader service coupon or contact ServerTech, Level 7, 91 Phillip Street, Parramatta 2150; phone (02) 9891 0083.

DSL transceiver evaluation module

Brooktree's digital subscriber line (DSL) transceiver evaluation module (EVM) is claimed to allow complete evaluation of the Bt8960 single-chip DSL transceiver. It includes all software and hardware necessary to operate the chip at a 288kb/s line rate. Instructions are provided to modify the EVM to alternative higher and lower bit rates. BNC connectors allow connection of an external bit error ratio (BER) meter.

The module contains all necessary support circuits and an on-board power supply, so for evaluation it only needs a PC and a line simulator or cable farm.

A software package allows configuration and operation from a PC. All necessary cables and connectors are included. A PC with a '386 processor and VGA display running DOS 3.0 (or better) is required. Complete reference documentation includes the schematic, PCB layout, bill of materials, and external component specifications. The Bt8960EVM showcases the low power and high level of integration available with the Bt8960.



For further information circle 207 on the reader service coupon or contact Zatek Australia, PO Box 228, Burwood 2134; phone (02) 9744 5711.

Phone/fax modem system

The Sportster Voice 33.6K US Robotics fax modem provides voice mail, speaker phone and fax facilities in a single unit that costs less than $400.

The modem is suitable for use in both the home or office environment. It digitally records incoming voice messages for multiple voice mailboxes, and will signal an alphanumeric pager when fax or phone messages arrive, so they can be retrieved from a remote location. It can automatically detect an incoming fax call and switch to accept it, and also has a full duplex speaker phone.

The device allows faxes to be sent directly from a computer, including broadcasting a message to multiple addresses. Users can also create documents, then schedule them to be faxed at another time.

The Sportster product line includes internal and external V.34 fax modems for computers running Windows 95, and an external V.34 fax modem for Macintosh computers. All three models include the V.34 speed enhancement which increases the modem's top speed from 28.8kb/s to 33.6kb/s as well as boosting throughput at lower speeds. Sportster Voice is also compatible with modems from 14,400 down to 300b/s. RRP of the internal unit is $315, and $365 for an external unit (incl sales tax).

For further information circle 204 on the reader service coupon or contact Modem Connection, 113 High Street, Northcote 3070; phone (03) 9482 6557, BBS (03) 9482 6548.

READER ONFO NO.19

New 33.6kb/s modem range

After extensive testing at various locations around Australia, Ellcon has recently released its 33,600b/s model modems. The range currently includes external and internal models, while a PCMCIA modem is planned for the future.

Ellcon has shown its commitment to the Australian market by supplying a development engineer who has worked closely with the technical staff of Ellcon's sole Australian agent, Skandia Electronics, to overcome the dial tone problems associated with the various levels of dial tone throughout Australia.

The new 33600 modems offer features such as error correction; data compression; auto dial and auto answer; MNPIO data throughput enhancement; and both asynchronous and synchronous communications modes. The modems come complete with Win'95 drivers, line cords, power adaptors and are Austel approved. Skandia also offers toll-free technical support on all modems sold.

For further information circle 208 on the reader service card or contact Skandia Electronics, 183 Burwood Road Hawthorn 3122; phone (03) 9819 2466, or fax (03) 9819 4281.

Multiplexer for video, audio, data

The 0SD391/393 is OSD's latest product in CCTV fibre-optic transmission of two, three or four video signals and optional transmission of four audio and data channels, which can be in one or both directions. There is also an optional reverse channel for video synchronisation.

The unit can operate to 50km (although 100km is possible with optional 1550nm operation) and can operate on either single-mode or multimode fibre. It features immunity to electrical interference, and low radiation with complete end-to-end isolation. Applications include CCTV networks, video conferencing, transportation networks, industrial monitoring systems and distance learning.

For further information circle 205 on the reader service coupon or contact Optical Systems Design, PO Box 891, Mona Vale 2103; phone (02) 9913 8540. ❖

NEW PRODUCTS

Programmable video generator

Leader Instruments has released its new LT1610 programmable video generator. The instrument can handle a wide range of displays, from flat panel LCD to CRT, and can be controlled from an external personal computer through an RS-232C interface.

The instrument has an 8-bit digital 120MHz dot clock and an analog RGB 150MHz dot clock output. It features programmable functions such as horizontal timing, vertical timing, output conditions and output patterns under a Windows environment, and also allows the user to draw patterns using a graphic function. The generator is suited for production and inspection applications, service departments, and R&D.

For further information circle 241 on the reader service coupon or contact Stantron Australia, PO Box 4760, North Rocks 2151; phone (02) 9894 2377.

All-in-one clamp meter

The new Fluke 36 clamp meter is claimed to be a full-featured AC/DC troubleshooting tool ideal for those working on sophisticated power systems and controls.

The meter measures true RMS current and voltage, DC current and voltage, resistance and continuity and shows readings on a 2000 count liquid crystal display. Ranges are 0-600A AC, 0-1000A DC, 0-600V and 0-200Ω. The continuity beeper function operates when resistances are less than 30 ohms.

Features include a maximum reading hold function for checking inrush currents on motors or the maximum load on a circuit. Designed to UL, CSA and TUV, the meter complies with IEC 1010 safety standards. It comes with Fluke Hard Point test leads, a protective soft carrying case, 9V battery and is covered by a one year warranty.

For further information circle 247 on the reader service coupon or contact Obiat, PO Box 37, Beaconsfield 2014; phone (02) 9698 4111.

4W DC-DC converters in DIL 24 package

Melcher has released its new IMX 4 series of rugged three to four watt DC-DC converters. They are available with two different input voltage ranges: 8.4 to 35V and 16.8 to 75V. They have either a single output of 3.3V or 5V, or dual outputs of +/-5V, +/-12V and +/-15V, allowing a configuration of output voltages from 3.3V to 30V.

The converters feature an efficiency of 82% (typ.), and an output power of up to four watts over the ambient operating temperature range -25 to +71°C. Extended temperature ranges of -40 to +7°C or -40 to -85°C, without derating, are available as options.

The flat DIL 24 package is 8.5mm high, and units are optionally available with the two most common pinouts. An SMD version is also available.

The converters meet safety standards IEC 950, UL 1950 and EN 60950. They have an input to output isolation of 1500V DC, low electromagnetic emission, and a high immunity to electromagnetic disturbances according to IEC 1000-4-2,-3, -4, -5 and -6. The converters are designed for applications in rugged environments, both mobile and stationary. Applications include aviation, mining and off-shore equipment, also telecomunications.

For further information circle 246 on the reader service coupon or contact Scientific Devices Australia, 2 Jacks Road, South Oakleigh 3167; phone (03) 9579 3622.

SMD removal kit

The Chip Quik kit is designed to allow the removal of surface mounted devices and other multiple connection components from PC boards, without damage to the board or components. The kit contains a special removal alloy solder braid for clean-up, liquid flux that's used with the alloy and braid, and instructions.

The only tools required to remove components are a 12 to 30W soldering iron, a dental pick and a cotton swab. One kit is sufficient to remove eight to 10 devices. To use the kit, the liquid flux is applied to all leads of the SMD being removed. A soldering iron is then used to uniformly melt the low-temperature (less than 93°C) desolder alloy onto all pins of the device. The iron is used to keep the desolder alloy in a molten state long enough to react with the existing solder. Then the SMD is lifted from the board with a dental pick or tweezers.

The PCB is cleaned with a cotton swab dipped in flux and a soldering iron to push large globs of desolder alloy to unused sections of the board. Once solidified it can be easily removed.

For further information circle 242 on the reader service coupon or contact Computronics International, PO Box 8076, Perth Business Centre, Perth 6849; phone (09) 221 2121.

CCD camera in a cube

The new Mini Cube CCD video surveillance camera model CAM-BW512 has a 3.6mm lens and is housed in a robust aluminium case. It measures 42mm (w) x 47mm (h) x 42mm (d) and weighs 165 grams, making it suitable for discreet installations, but obvious enough to be seen if required.

The camera has UNC threaded mounting points at the top and bottom of the case, and a suitable swivel aluminium bracket (44 x 40mm) is also available. Specifications include better than 380-line horizontal resolution, 0.2 lux sensitivity for low light and infrared use, 1/50 to 1/100,000 sec automatic electronic shutter, 12V DC supply with 2.1mm socket, standard 75 ohm composite video with RCA socket. It is priced between $99 and $159.

For further information circle 245 on the reader service coupon or contact Allthings Sales & Services, PO Box 25, Westminster 6061; phone (09) 349 9413.

New lead-acid battery design

The new Optima YellowTop semi-traction battery from Gylling Optima Batteries is claimed to not only provide starting power but can also deliver current for traction applications. It is believed to be one of the first of its kind to be able to successfully combine the conflicting requirements of starting and traction.

The battery is based on the company's SpiralCell technology, in which spiral-wound cells replace the flat plates of traditional lead-acid batteries. This allows the battery to deliver the same current as a conventional battery two or three times its size.

The internal design features a sealed electrolyte in a closed system, giving several practical and environmental benefits. It contains only 30 components, is robust, maintenance-free and fully recyclable. There is no liquid to be topped-up or checked and, as the battery does not leak, there is no corrosion at the poles. It also tolerates extremes of temperature better than conventional lead-acid designs.

The battery can be used in a range of applications, including passenger cars, caravans, yachts, boats and a range of commercial and industrial vehicles. It has undergone field testing with a number of customers world-wide.

Specifications include a cold cranking current of 700A; energy rating of 624Wh (C/5 rate), 672Wh (C/20 rate); 350W/kg (100% state of charge) and an internal resistance of 2.8mΩ. Dimensions are 245 x 172 x 200mm (LxWxH), weight is around 21kg (12V) or 11.8kg (6V version).

For further information circle 249 on the reader service coupon or contact Optima batteries (Aust), 441 Station Street, Box Hill 3128; phone (03) 9897 3999.

12-channel GPS development kit

The GPS Builder from GEC Plessey Semiconductors is a development kit which can provide a fully functional demonstration of a 12-channel GPS receiver, when installed in a 486DX PC and coupled to an external antenna, which is also provided in the kit.

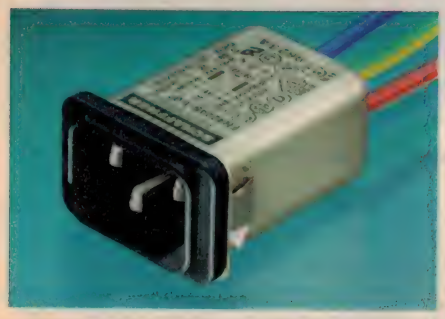
The kit is a prototyping aid for basic GPS receiver design and is based on the GP2015/GP2021 chipset. Included in the kit is the necessary software both in executable format and source code for further development. It has a 12-channel receive architecture, and comes with active antenna and suitable cable, ISA bus interface card and software.

Host PC requirements are a 50MHz 486DX, a free ISA bus expansion slot, MS DOS version 5 or above, and Borland C++ (rev 3.1 or 4.0) to recompile the source code.

The GPS Builder board set has as its core an ISA interface card containing the GP2015 RF down-converter IC, a DW9255 SAW filter and the GP2021 12-channel correlator. This chip set provides full 12-channel capability, enabling 'all in view' tracking. The correlators are controlled by the host microprocessor via the ISA interface card.

For further information circle 243 on the reader service coupon or contact GEC Electronics Division, Unit 1, 38 South Street, Rydalmere 2116; phone (02) 9638 1888.

Snap-in power filter modules



Schaffner's latest IEC 950-compliant powerline filter modules feature snap-in panel fixing. The new FN 9224 IEC inlet filters are based on the company's FN 9223 range, but are equipped with higher value inductors and capacitors for increased rejection of common and differential mode interference. The filters weigh 45grams and measure 34mm wide by 22.5mm high, with a behind-panel depth of 37.7mm.

All modules have a maximum operating voltage of 250V AC at 50Hz and an operating frequency range of DC to 400Hz. They are available with a current rating of 1, 3, 6 or 10A, and for medical applications can also be supplied in a class B version, which offers lower leakage currents and a capacitor discharge resistor.

For further information circle 244 on the reader service coupon or contact Westinghouse Brake & Signal Company (Australia), Industrial Products, Locked Bag 66, South Melbourne 3205; phone: (03) 9676 8888.

Networked radio system

Tait Electronics has launched its new T3000 series II radios as replacements for its series I models. Improvements include enhanced durability and protection against harsh conditions.

There are a total of five models in the range, covering both conventional and MPT1327 requirements.

The series also incorporates a range of additional features in its operational capability, as a result of software enhancements. These features have increased functionality in the MPT1327 trunked radio models. Like its predecessor, the new series is rated to US Military Specification 810C, D and E. A new and intelligent fast battery charger (T3002) is also available.

For further information circle 248 on the reader service coupon or contact Tait Electronics (Aust), PO Box 679, Virginia 4014; phone (07) 3260 7799. ❖

READER INFO NO.24

Silicon Valley NEWSLETTER

IBM to focus R&D on networking

IBM, which spends in excess of US$6 billion a year on research and development, has announced a major shift in its R&D programs. These will now focus heavily on computer networking technologies, including the Internet and intranets. The company said it will devote at least 20% of the money, or about US$1.2 billion, on network-related R&D.

"This is a fundamental realignment of our $6 billion research budget. We're going to focus on delivering integrated solutions, and not raw technologies," said IBM chief Lou Gerstner at a gathering of more than 5000 information technology industry executives.

Gerstner said that he and other top IBM executives had reviewed the company's R&D programs and had cut scores of projects, including some Gerstner himself had favoured. "We picked the winners and losers. We now kill projects faster than we ever used to."

On the subject of the Internet and the browser war that Microsoft and Netscape are waging, Gerstner advised the audience to dismiss the attention to the subject as pure media hype. "Forget browsers. They are only the beginning, not the end in networking. They are today a subject to sell magazines and newspapers", Gerstner said, noting that most browsers are given away instead of being sold.

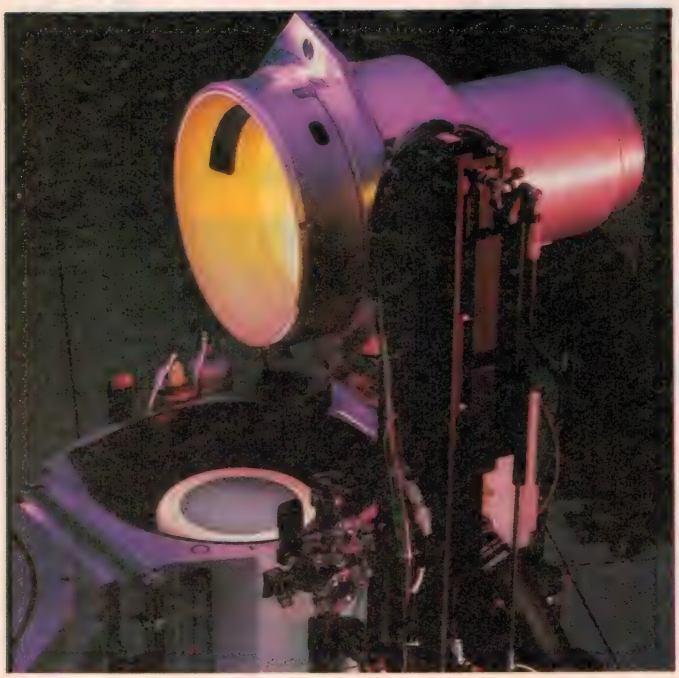
LSI Logic tackles DVD chip market

Taking a big shot at the potentially huge future market of digital video disk (DVD) semiconductors, LSI Logic has introduced a highly integrated, low-cost single chip decoding engine designed for a broad range of DVD applications. The chip combines nine separate cores, with more than two million transistors and 45 memories. "By rapidly developing cost effective, single-chip DVD solutions, LSI Logic will help play a significant role in accelerating the widespread adoption of DVD products", said LSI chairman Wilf Corrigan.

Shipments of DVD players and drives are expected to reach sales of more than 33 million units by the year 2000, making it one of the most successful products of the decade, said Dale Ford, senior industry analyst at Dataquest market research. "DVD will drive the huge demand for semiconductor content, and LSI Logic is well positioned to take advantage of this fast-growing market."

LSI Logic's DVD decoder integrates functions including Dolby Digital (AC-3) audio decoding technology to provide stereo surround sound, and MPEG-2 audio/video decoder circuitry. The chip supports major DVD features like pan and scan, and letterboxing to view widescreen movies on a conventional screen. The integrated sub-picture unit also adds graphics such as movie subtitles.

The chip will be shipping in volume during the second quarter of 1997.



Fremont-based Lam Research, a leading manufacturer of etching and deposition equipment for chip fabrication, recently unveiled its TCP (transformer coupled plasma) 9100 high density oxide etch system. It's claimed to be the first such tool capable of etching devices in the deep submicron (0.35um to 0.18um and below design rule) region.

Intel's value now US$83 billion

Back in the early 1980s, a struggling and financially strapped Intel signed a technology sharing agreement with IBM that gave the Santa Clara chipmaker a much needed financial infusion of around US$250 million. Recently Intel's shares rose to a record US$101.69 per share, bringing the company's book value to an astonishing US$83.6 billion, just ahead of Microsoft at $81.3 billion and way ahead of IBM at $66.7 billion.

Already in control of 85% of the PC market, Intel's future looks very bright as its Pentium Pro chips are beginning to make waves in the workstation and server markets, and PC and consumer electronics manufactures around the world are designing Intel's chips into an ever broadening range of products. Intel's nearest competitor, Advanced Micro Devices, continues to struggle getting new Pentium-compatible chips to market and even the PowerPC chip has largely failed to make an impact on Intel's dominance.

Motorola develops 'software modem'

Future personal computers will be able to communicate data and access the Internet without the aid of a modem, according to Motorola. The company said its Integrated System Group (ISG) has developed a software-based communications system that replaces modem chips, boards, and external devices.

The first of the modem programs will become available before the end of the

year and offer 28,800b/s transmission capability. PCs with Pentium processors (150MHz or higher) and Windows 95 will be required to run the software. A Macintosh version will be available in 1997. The technology uses a portion of the vast amount of processing power that lies idle during most of the time a PC is in use.

Patrick Casey, a Motorola marketing director said software-based modem products will come to dominate the communications peripherals market. Hardware-based modem sales could fall from US$2 billion in 1995 to $600 million in 2000, due to the impact of software-based products.

One of the advantages of software-based modems, Motorola said, is that they will be able to take better advantage of higher communications speeds that will become available with the adoption of digital phone lines and cable modems.

The idea of using the MPU for tasks typically performed by peripherals or specially designed chips and boards was first proposed by Intel chief Andrew Grove, in a keynote address at the 1994 Comdex show in Las Vegas. Intel's Native Processing Initiative met a huge amount of resistance, especially from Microsoft. Intel later backed off from the idea.

Agreement on data encryption system

After a five-year battle, the Clinton Administration, CIA, and computer hardware and software industries have agreed on a deal which will remove all export restrictions on public key-type data encryption technology — in return for a complex scheme that would still give US authorities access to data to help unscramble encrypted messages.

Under the terms of the deal, which reportedly has been approved by the CIA, US law enforcement agencies, including national security agencies, will first have to obtain a warrant from the court. The warrant would enable the agents to seek cooperation from an outside company to unscramble the code used to encrypt messages.

The solution was proposed to the government by a consortium of companies headed by IBM. Digital Equipment and data security firms such as RSA Data and Cylink are also supporting the deal. Vice president Gore said that if the deal is adopted, he sees no reason to maintain any export controls on encryption technology.

Until now, the CIA and National Security Agency have opposed the export of leading edge data encryption without a means for the government to gain access to the information being transmitted. They have argued that terrorist organisations and terrorism-sponsoring countries, drug traffickers, and various crime organizations would quickly adopt encryption technology that would not be accessible by even the most powerful supercomputers employed in America's counter-intelligence and law enforcement operations.

A major break in the five-year impasse came in 1995, when IBM showed an experimental system based on the new approach to CIA director John Deutsch. After gaining support in his own organisation, Deutsch then lobbied the FBI and US Justice Department, which had taken an equally hard line on the issue of access.

Japan wants different marketshare system

A Texas Instruments DRAM chip produced in Japan and purchased by a Japanese electronics manufacturer is counted as a domestic chip, while an NEC DRAM chip manufactured at the company's Roseville, California facilities is also counted as a domestically-produced component, in the formula currently used by the US and Japanese governments to determine the foreign share of Japan's vast chip market. But Japan's industry and trade officials have begun a campaign to alter the way chips are counted, saying the current formula doesn't reflect marketplace realities.

Under proposals submitted to the recently created World Semiconductor Council by Japan's Electronics Industry Association of Japan (EIAJ), the foreign marketshare formula would simply consider *where* a chip is manufactured, rather than by whom. Thus a TI chip made in Japan would still be counted as a domestic product, while the NEC chips that are shipped back to Japan would be counted as foreign-made. Also, chips made by a US/Japanese joint venture firm would no longer be calculated as 50% foreign, but listed as made in the country where the joint venture is located.

While this may seem reasonable, the US Semiconductor Industry Association is not buying the proposal, saying it could paint an 'even worse' picture of the openness of Japan's market than the one produced by today's formula.

Most Japanese chip producers have now moved a substantial portion of their chip production outside Japan, where it has become too expensive to produce many semiconductors competitively. Adding these off-shore produced chips to the foreign side of the marketshare figure, the proportion that Japanese electronics firms purchase from foreign suppliers would likely jump dramatically from the current 30% level. ❖

"No profits in Internet until 2002" — Gates

Bill Gates does not expect Microsoft to make significant profits from its Internet products and services for five to 10 years, due in part because of the company's small share of the browser market, and in part because there simply won't be a lot of money to be made in cyberspace for anyone.

Gates spoke during a panel discussion on the Internet, during which he sat sandwiched between two of his chief Internet rivals — James Barksdale, CEO of Netscape Communications, and Steve Case, head of America Online.

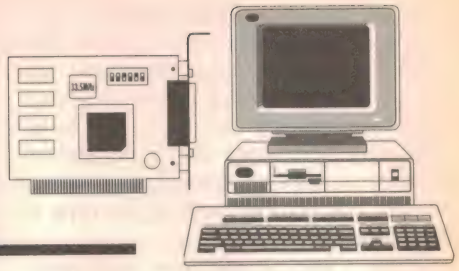
"We will only make money in the interactive areas, where we are number one or two, and we will only make money when the Internet becomes part of everyday life", Gates told the audience of some 5000 information systems executives. "It will be five to 10 years before the Internet will start playing pivotal role for a significant portion of the population in the industrialized part of the world."

Gates predicted that in five years, personal computers will be using a single universal interface for virtually every PC function — from scrolling through text, database and spreadsheet documents to browsing a Web site. Computers will also move to voice command, and, using digital cameras, recognise a user's gestures such as a slash across one's throat meaning for the system to shut itself down. "If someone frowns while using one of our products, we will know about it", he joked.

"Interesting predictions, but it is difficult to say if they will come true," responded a skeptical Barksdale. "Despite my learned colleague's comments, five years is hard to predict in this business. All of us tend to mistake clear vision for a short distance." Barksdale also took issue with Gates' contention that there may not be a lot of money to be made in the Internet market in the near term. "The Internet market will become a huge market and will become important within corporations."

Barksdale also took the opportunity to tell Gates and the audience Netscape's vision of what the US Government should do with Microsoft. He said the government should classify Microsoft, which controls 85% of desktop PCs, as a utility company subject to federal regulations designed to prevent it from using its vast power in one market to trample competition in other segments.

Computer News and New Products



Monitor can be calibrated

Aimed at the design and photo-retouching markets, the new Barco Personal Calibration 21" monitor can be calibrated with a range of external calibrating devices. The monitor comes with a new Lite version of Barco's CalibratorTalk colour calibration software. This program provides on-screen, menu-assisted control of the calibration process. It allows the generation of high quality profiles in Colorsync II or ICC formats.

Calibration is done with a third-party calibration device. Instruments currently supported are Light Source's Colortron hand held spectrometer and the X-Rite DTP92 colorimeter. Support for other devices is currently under development. To avoid banding problems in the image, the monitor has full 24-bit colour, without sacrificing colour resolution in the graphic board for calibration purposes. This is claimed to eliminate the need for a more expensive 30-bit graphic board. The pixel resolution of the monitor is programmable up to 1600 x 1280.

For further information circle 161 on the reader service coupon or contact Trace Pacific, 8 Prohasky Street, Port Melbourne 3207; phone (03) 9646 5833.

Half-size Pentium CPU card has VGA

Intelligent Systems Australia has released a new all-in-one Pentium CPU card. The AP-5200SH is a full-function half-size card which supports VGA and other enhanced I/O interfaces. It uses a Pentium series CPU (up to 200MHz), can have up to 64MB of DRAM and also provides a cache module slot which allows a pipelined-burst synchronous or asynchronous SRAM module up to 512KB.

The card has one enhanced IDE interface for up to two IDE devices, one floppy disk drive controller, two RS-232 serial ports and one high performance multimode parallel port. Its high-performance PCI true-colour graphics accelerator supports shared memory architecture to share the all-in-one CPU card memory.

The card is suited for industrial process control or embedded system applications such as POS systems, automation control and machine control.

For further information circle 160 on the reader service coupon or contact Intelligent Systems Australia, PO Box 118, Berwick 3806; phone (03) 9796 2290. (Internet site at **http://www.intelsys.com.au**)

Software supports CPLD devices

Philips has announced the availability of XPLA Designer, a software package to support the company's new CoolRunner 3V and 5V CPLD devices. Third-party agreements with vendors such as Synario Design Automation, MINC and ISDATA give access to Philips' CPLD technology using computer-aided engineering (CAE) tools within Mentor Graphics, Cadence, Viewlogic and Synopsys environments.

The software is a Windows (3.1x and 95) based tool that offers design entry, editing, synthesis, device fitting, functional simulation and full timing simulation. Design entry is achieved via Philips' hardware description language, claimed as a familiar, easy to use language that offers entry via both high-level constructs and low-level directives. Support is included for popular state machine constructs, truth tables, and Boolean equations.

The Philips 100K gate ASIC simulation engine is accessed via both a graphic waveform editor/viewer and a full simulation control language to allow users to simulate designs via interactive waveform entry and analysis, as well as developing extensive simulation scripts for complex vector patterns. The program generates industry-standard VHDL and Verilog timing models for board-level simulations. Philips' 3V PZ3032 and 5V PZ5032, both 32 macrocell parts, are the first production devices to be supported, and 64 and 128 macrocell parts are supported in their preliminary form.

For further information circle 166 on the reader service coupon or contact Philips Components, 34 Waterloo Road, North Ryde 2113; phone (02) 9805 4479.

Low cost colour inkjet

Epson has released the Stylus Color 200, a new entry-level colour inkjet printer with a print resolution of up to 720 x 360dpi. Based on Epson's EPMACH inkjet technology, it uses short electrical pulses to charge and fire ink droplets out of the ink chamber.

Features include a range of resident bitmap and scalable fonts. For black-only text printing, the colour cartridge is replaced with a black ink cartridge.

The printer comes with a new printer driver that automatically adjusts colour settings. It's compatible with both Windows 3.1 and Windows 95 operating systems. It supports Plug and Play and image colour matching (ICM), and features an on-screen monitor that displays ink levels. The printer has 720, 360 or 180 print resolutions and the built-in sheet feeder holds up to 100 A4 sheets. It has a two-button control panel and an indicator to show when the ink is running low.

The printer is priced at $395 (inc tax); a black cartridge is $35 and a colour cartridge costs $50.

For further information circle 162 on the reader service coupon, see your local Epson dealer or contact Epson Australia, 70 Gibbes Street, Chatswood 2067; phone (02) 9903 9000.

DRAM tester handles 128MB

Chroma Industries has announced a new DRAM tester, model 3202. It is designed to provide a range of tests for all types of DRAM memory devices including SIMM, SIPP and the new DIMM modules, up to 128MB maximum capacity.

The tester is a small portable unit and has an internal high speed CPU, coupled with 1GB address space to facilitate testing large capacity memory devices. It uses proprietary software (Chroma 3202), tests the access time of every memory cell (from 40 to 120ns) and verifies memory configuration, R/W functions etc.

A large variety of data patterns and test patterns are stored in the test library. An on-board LCD shows all functions and the test setup is selected from the front panel function and data keys. Setups can be stored in the device's internal non-volatile memory. The test result is shown on the display. A Centronics port is provided for printouts of test results, and to allow the tester to be operated from a PC for auto handling.

For further information circle 163 on the reader service coupon or contact Nucleus Computer Services, 9B Morton Avenue, Carnegie 3163; phone (03) 9569 1388.

Free schematic viewer

Ivex Design International has announced the availability of WinDraft Schematic Capture version 1.26, a program which allows any version of WinDraft, including the 100-pin capacity shareware version, to act as a 'schematic viewer' to show any size sheet. WinDraft's view mode is analogous to Microsoft's Word 6 viewer and allows the user to view a document without having to purchase a full version of the software.

According to Saige Losli, Director of Engineering, "Thousands of designers need a viewer to exchange files. WinDraft 1.26 gives the ability to freely distribute schematics in a standardised format to anyone, anywhere; even across the Internet". WinDraft 1.26 is a free upgrade to any current WinDraft user, obtainable by downloading it from the Ivex World Wide Web site at **http://www.ivex.co**".

New features of WinDraft 1.26 include the ability to view any size sheet created with a licensed copy of WinDraft Schematics, added printing functionality and user definable attribute fields to include a bill of materials. It also has an improved library editor and a revised 'getting started' guide that includes netlist information.

It is claimed to be an ideal front-end for WinBoard PCB layout. For further information circle 167 on the reader service coupon or contact ME Technologies, PO Box 50, Dyers Crossing 2429; phone (065) 50 2200. ❖

Network tape backup

Hewlett-Packard has announced its new Travan 4 technology drive, the HP SureStore T4i. Designed for HP NetServers running Novell NetWare and Windows NT, the drive uses industry standard QIC-3095 format and is specified as having 200,000 hours MTBF (mean time between failure).

Features include on-the-fly formatting, with factory-written servo bursts to ensure accurate track alignment during both write and read passes. It has a 25 second average file access time and comes with a two-year warranty or a matching three year on-site warranty if sold with a HP NetServer. Pricing will be around $850, including sales tax.

For further information phone the HP Customer Information Centre on 131347. Information about HP products is on the Web at **http://www.hp.com**.

Intelligent peripheral controller cards

A new line of intelligent peripheral controllers (IPC) has been announced by Decision Computers. The modular hardware can be purchased on an 'as you need' basis. The IPC series microcontrollers consist of a high speed Z80 CPU card which also has an on-board operating system for system development, and various I/O cards to suit specific applications. All cards are based on a 100 x 60mm Eurocard size format and can be installed in a standard metal or ABS case.

Programming can be done with any IBM compatible PC running DOS or Windows, and cross-assembler or C-cross compilers are available. Applications can be downloaded to the CPU card for testing and debugging, and when completed, the program and the operating system can be burned into EPROM for permanent storage. An RS-232 terminal (or a PC with a terminal emulation program) can be used to communicate with the CPU card directly.

The operating system includes drivers for the serial port and the optional keyboard, LCD and real-time clock. Most peripheral cards are interrupt driven to minimise overhead and maximise CPU efficiency. The expansion connector combines a maximum of eight peripheral cards and each card has its own I/O number and bank selector. Currently 18 I/O cards are available, including graphic LCD display systems, motor controllers, bar code/MCR reader and 12 bit A/D boards.

For further information circle 164 on the reader service coupon or contact Nucleus Computer Services, 9B Morton Avenue, Carnegie 3163; phone (03) 9569 1388.

PC card allows comms via GSM, PSTN

Banksia Technology has released the GSMCard, a novel dual-mode PC Card modem that allows fast and easy communications over the standard phone system (PSTN) as well as any GSM mobile network. Mobile professionals with notebook or laptop PCs can send data, faxes and e-mail over either network, thereby bringing the 'virtual office' concept a step closer to reality.

The Type II PC Card transmits data at 28,800b/s (or up to 115,200b/s with data compression) and fax at 14,400b/s over the PSTN. Data and fax can also be sent at the standard GSM rate of 9600b/s.

Features include Plug and Play configuration, easy to use GUI software, flash memory, volume control, multi-country usage, and error correction over both PSTN and GSM networks.

Connnection to the GSM network is simple: a Banksia GSM-activation kit, sold separately, transforms the card into a data/fax modem enabling wireless communication at up to 9600b/s. Kits are available for a wide variety of GSM phones, including market leading Panasonic, Siemens, Sony, Nokia, Ericsson and shortly, Motorola models. Each connection kit contains the cable and software for a specific GSM handset.

Installation is a breeze with Banksia's Interactive Manual for Windows. Configuration is completed by simply clicking on the desired icons (such as data compression, error correction, and passwords). As well as a complete list of modem AT commands, the programme also contains an interactive diagnostic facility that guides the user through any modem problems.

RRP for the GSMCard is $749, while the GSM-activation kit retails for $249.

For further information circle 168 on the reader service card or contact Bansia technology at 25 Sirius Road, Lane Cove 2066; phone (02) 9418 6033, or fax (02) 9428 5460.

New HP LaserJet 6 printers

Hewlett-Packard has introduced its first HP LaserJet 6 Series printers, the HP LaserJet 6P and 6MP printers. The new printers replace the HP LaserJet 5P and 5MP printers and offer significant performance enhancements at lower prices than their predecessors. The printers are priced at $1425 and $1805 respectively, including sales tax.

The 6P and 6MP offer fast eight page per minute (ppm) print speed, high-quality 600dpi output and versatile paper-handling capabilities. The printers are also expandable, allowing small work teams and advanced individual users to add options.

The HP LaserJet 6MP printer offers the same functionality and benefits as the HP LaserJet 6P printer, as well as compatibility across Macintosh and Windows PostScript environments. Its flexible paper-handling capabilities and high-quality graphics output make it attractive for desktop publishers and graphics professionals who need a PostScript printer.

Both the 6P and 6MP printers include built-in infrared (IR) technology for simple 'point-and-shoot' wireless printing, making it easy for users to print directly from notebook computers, palmtops and personal digital assistants (PDAs) without having to connect to a printer or transfer files to a PC that has printer access. The new printers feature an IR data-transfer rate of 4Mb/s — almost 10 times faster than that of the HP LaserJet 5P and 5MP printers — enabling users to print documents at speeds comparable to

a standard parallel-port cable connection. Information about HP and its products can be found on the World Wide Web at **http://www.hp.com**. Readers may also obtain further information on HP products and services, toll-free Australia-wide, by calling 131347 (no STD area code required).

Optically isolated I/O card

Intelligent Systems Australia has released the Pi-426, a 16-channel optically isolated digital input and eight-channel relay output interface board for data acquisition and control with an IBM compatible computer.

Each eight-channel digital input port can generate an interrupt request to the PC whenever one of 16 D/I channels or inputs change. The interrupt level is set by using a DIP switch (IRQ2 to IRQ7).

There are two jumper selectable input modes: DC voltage input or dry contact input. When set to DC input mode, the board can accept a DC voltage from 3V to 24V; if set to dry contact mode it can detect dry contacts by using an external power source or the internal 12V DC.

The card also provides eight electromechanical SPDT relays. Each relay is equipped with a LED that lights when the associated relay is energised. The relay outputs have a 40-pin FRC connector and an FRC to D-type cable. The card is suited to applications such as digital data input, counter closure monitoring, dry contact sensing and power on/off control.

For further information circle 165 on the reader service coupon or contact Intelligent Systems Australia, PO Box 118, Berwick 3806; phone (03) 9796 2290. ❖

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KEY TO CODING

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OTHER QUERIES: Technical queries outside the scope of 'Replies by Post', or submitted without fee, may be answered in the 'Information Centre' pages at the discretion of the Editor.

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ADVERTISING INDEX

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#101

OVERSPEED MONITOR KIT

Gives a pulsed tone signal when preset speed is exceeded. Speed is set by a potentiometer: travel at the desired speed and adjust pot until tone is heard, then mark pot position for future reference. Requires two connections to vehicle: +12V and ground. A small PCB is provided for a Hall effect pick-up sensor. This assembly is mounted near the drive shaft and connected to the main PCB by three wires. Kit includes two PCBs and all on-board components, a small speaker, and even two small powerful 'rare earth' magnets: **$22** Plastic case to suit: **$4.**

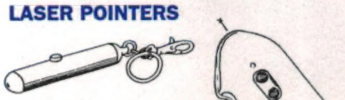
COMPUTER CONTROLLED STEPPER MOTOR DRIVER KIT

Kit will drive two 4, 5, 6 or 8-wire stepper motors from an IBM computer parallel port. Motors require a separate power supply (not included). Includes detailed manual and software (on 3.5" disk). NEW SOFTWARE will drive up to 4 motors (needs two kits), with linear interpolation across four axes. PCB 153 x 45mm, all on-board components, manual, software and two suitable stepper motors: **$44** This kit with the stepper motor pack: **$65** Kit, no motors: **$32**

UNIVERSAL TEMPERATURE CONTROLLER

This kit controls temperature by switching power on and off to a heater or a cooler. Useful for incubators, aquariums, air conditioning etc. Has a thermistor to sense ambient temperature and switches a MOSFET that can handle up to 10A 50V DC directly. Use a relay for isolation if necessary. Includes status indicator LEDs, operates from 11 to 25V DC. Use a rewound jug element for a cheap heater element. PCB and all on-board components: **$19**

LASER POINTERS



Two 5mW at 660nm (very bright!) laser pointers. One type in a small flat plastic case, the other in a small metal cylindrical case fitted with a keychain. Both powered by 3 LR44 batteries and APC driver circuitry. Greatly reduced prices: **$55 ea**.

UV MONEY DETECTOR

Portable UV source. Has two AA batteries and an inverter to step up the voltage to power a 50mm long, cold cathode UV tube. Simple circuit. Inverter can dimly light a 4W fluoro tube. Takes about 250mA. Case 82 x 46 x 21mm: **$5** ea or **5 for $19**

GEIGER COUNTER KIT

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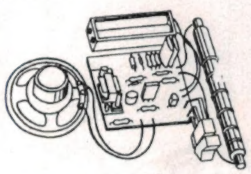
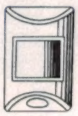


Based on a Russian Geiger tube, has traditional 'click' to indicate each count. Kit includes PCB, all onboard components, a Money Detector (see above), speaker and YES, the Geiger tube is included. **$30**

PIR MOVEMENT DETECTOR



Commercial quality 10-15M range PIR movement detectors. Second hand, tested and guaranteed, have relay contact outputs, a tamper switch and operate from 12V DC. Compatible with standard alarm systems. Includes circuit. **$10** ea. or **4 for $32**

PIR CASE FOR CCD

Used cases from PIR movement detectors, with Fesnel lens and PCB. Ideal as a case to conceal a CCD camera. **$2.50 ea** or **4 for $8**

PLASMA EFFECTS SPECIAL

Ref: EA Jan '94. Produces a fascinating colourful high voltage discharge in a domestic light bulb, or light up an old fluoro tube or any gas filled bulb. The EHT circuit is powered from a 12V to 15V supply and draws a low 0.7A. Output is about 10kV AC peak. PCB and all on-board components (flyback transformer included), and instructions: **$28** (cat K16) Hint: connect the AC output to one of the pins of a non-functional but gassed laser tube, amazing results! The special? We supply a low power functional laser tube for an additional $14, but only if purchased with the plasma kit. Total price: **$42** (Includes instructions on getting the laser tube to produce a laser beam!)

FOG MACHINE

Mains operated fog machine: 700W, 3000 cubic meter per minute capacity, remote operation with lead supplied. Great for light shows and lasers! Low introductory price: **$300**

VIDEO TRANSMITTER

Low power UHF TV transmitter with adjustable level audio and video inputs, power switch and power in socket. Needs 10 to 14V DC at 10mA. Set to Ch 31, can be altered. Video input accepts standard composite video (eg CCD camera), comes in small metal box and built-in telescopic antenna. Range typically 7 to 10m for internal TV antenna: **$25**

RARE EARTH MAGNETS

Very strong!!! Zinc coated. Cylindrical: 7 x 3mm, **$2** (G37) 10 x 3mm: **$4** (G38), toroidal 50mm outer, 35mm inner, 5mm thick: **$9.50** (G39)

IR REMOTE CONTROL TESTER

Kit includes a blemished fibre optic coupled IR converter tube with either 25 or 40mm diameter window, and our night vision HT power supply kit. The tube responds to IR and visible light, and can 'see' the output of an IR remote control. **$30**

LED FLASHER KIT

3V operated 3-pin IC that flashes 1 or 2 high intensity LEDs. Very bright and efficient. IC, two high intensity LEDs and small PCB: **$1.50** ea, **10 for $12**

SIMPLE MUSIC KIT

3V, 3-pin IC plays a single tune. Two ICs that play different tunes, speaker and small PCB: **$3** or **10 for $25**

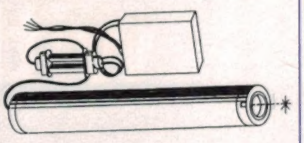
MAGNIFIERS - LOUPES

Four types (see review S.C. May 96). Small jewellers eyepiece with plastic lens: **$3**. Others in the range have two glass lenses, used where the loupe is placed close to the object being magnified. Focal point just below base of the loupe. Loupe with 50mm dia viewing area, 10 x mag: **$8**, 75mm: **$12**, 110mm **$15**.

AUTOMATIC LASER LIGHT SHOW

New and simplified light show kit gives a similar display to the kit published in SC (May 96), but easier to assemble. It's also CHEAPER. Even has a machined washer for mounting the mirror on the motor shaft. Kit includes 3 motors, 3 machined washers, PCB and all onboard components. A random variety of patterns is produced. Each pattern changes after a few seconds. **$70**
Package deal that includes Laser Tube Supply (see below): **$150**

LASER TUBE SUPPLY



A low power, used HeNe tube head. Typical output is 2mW. Includes a potted mains power supply that has an isolated TTL level (3-5V) enable input. (Use two AA batteries and a switch.) Needs a mains plug. **$90**

SECURE IR SWITCH

Toggles a relay from an IR transmitter. Coded transmitter and receiver so a number can be used in the same area. Includes commercial one button transmitter, receiver PCB and parts to operate a relay (not supplied): **$22**

VISIBLE LASER DIODE KIT

We have redesigned our 5mW 660nm visible laser diode kit so the PCB fits neatly into a new hand held case (supplied). Complete pointer kit (with case) at a REDUCED PRICE of **$35.** A similar kit with a 5mW 635nm laser diode: **$85** (NEW LOW PRICING)

STEPPER MOTOR PACK

Pack of seven mixed stepper motors. Save 50%! All new: **$36**

PRICE RISE NEXT YEAR

Our accountant says we must increase all our prices by 10%, from January 1997. **So buy now and avoid the price rise!**

POWER MOSFETS

IRFZ44 N-channel MOSFETs at a realistic price for hobbyists. 60V (max), 0.028 ohm on-resistance, 50A (max). TO220AB package. **$4 ea, 10 for $30**

MINIATURE FM TRANSMITTER

Very small ready-made FM transmitter in a small black metal case. Powered by a 1.5V watch battery (included), has an in-built electret microphone. Tuning range: 88 to 108MHz (adjustable). Range approx 50m: **$32**

3-STAGE TUBE CLEARANCE

SC Nov. 95. 25mm 3-stage fibre optic night vision tube, works in starlight EHT supply kit and eyepiece. **$200**

SOLID STATE PELTIER DEVICES

12V 4.4A, can be used to make a thermoelectric cooler - heater. Basic info included. **$25** 12V DC fan **$8**

IR REPEATER KIT

Extend the range of existing remote controls up to 15m and/or control equipment in other rooms: **$18**

VISIBLE LASER DIODE MODULE

Industrial quality 5mW/670nm laser diode module. Dimensions: 12mm dia x 43mm long. Includes visible laser diode, diode housing, APC driver circuit and collimation lens all factory assembled in one small module. Has superior collimating optic, divergence angle less than 1 milliradian: **$65**
650nm version also available: **$65**

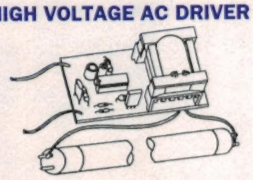
ALCOHOL BREATH TESTER KIT

Has high quality Japanese thick-film alcohol sensor. Kit includes PCB, all components, meter movement: **$30**

ARGON-ION HEADS

Used Argon-Ion heads with 30-100mW output in the blue - green spectrum. Head only supplied. Needs 3V/15A AC (for filament) and approx 100V/10A DC for the inbuilt driver circuitry. We provide a circuit for a suitable power supply. Dimensions: 35x16x16cm, weight 6.0kg. 1 year guarantee on head. Needs a 1kW transformer, available elsewhere for about $170. Argon head only: **$300**

HIGH VOLTAGE AC DRIVER



Produces a high frequency, high voltage AC for ionising most gas-filled tubes up to 1.2m long. It can partially light a standard 36W fluoro tube with two connections, taking less than 200mA from a 12V battery. Heat the tube filaments to get about 6W of light output. Includes PCB, small fluoro tube and components. **$18**

400x128 LCD MODULE

New Hitachi LM215 400 X 128 dot matrix LCDs in an attractive silver grey housing measuring 340 x 125 x 30mm. Driver ICs fitted but needs external controller. Effective display size 65 x 235mm. Basic data also provided. New and unused. **$25 ea or 3 for $60CCD**

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